INVESTIGATION OF 20 GALLON CHEMICAL FIRE EXTINGUISHERS

BY

C. W. MINTZ

F. A. TRASK

ARMOUR INSTITUTE OF TECHNOLOGY

1919

AN INVESTIGATION OF 20 GALLON CHEMICAL FIRE EXTINGUISHERS

A THESIS

PRESENTED BY

C. W. MINTZ AND F. A. TRASK

TO THE

PRESIDENT AND FACULTY

OF

ARMOUR INSTITUTE OF TECHNOLOGY

FOR THE DEGREE OF

BACHELOR OF SCIENCE

IN

FIRE PROTECTION ENGINEERING

MAY 29, 1919

APPROVED

J. B. Finnegan
Professor of Fire Protection Engineering

Dean of Engineering Studies

Dean of Cultural Studies

ACKNOWLEDGEMENTS

The apparatus and materials used in conducting these tests were furnished by courtesy of Underwriters' Laboratories, Chicago.

The authors wish to express their appreciation to Mr. N. F. Kimball, Associate Professor of Fire Protection Engineering at the Armour Institute of Technology; and to Mr. R. W. Hendricks, Hydraulic Engineer, Underwriters' Laboratories, for their valuable co-operation in this investigation.

TABLE OF CONTENTS

PART I.

Page

INTRODUCTION 5

PART II.

OBJECTS 8

PART III.

TESTS

Chapter I. Test Apparatus .. 11

Chapter II. Operation Test Methods 21

Chapter III Test Procedure .. 24

PART IV.

DATA AND CURVES 33

PART V.

DISCUSSION

Chapter I. Test Variables .. 123

Chapter II. Theory of Operation 130

Chapter III Design 134

PART VI.

CONCLUSIONS 139

L I S T O F I L L U S T R A T I O N S.

P L A T E I.

AMERICAN LA FRANCE (473) ..... Page 14

P L A T E II.

A.L.F. (473) IN OPERATING POSITION 15

P L A T E III.

O.J.CHILDS (585) EXTINGUISHER PARTS 16

P L A T E IV.

AJAX (609) 17

P L A T E V.

AJAX (609) IN OPERATING POSITION ..... 18.

P L A T E VI.

SPERO (608) 19

P L A T E VII.

SPERO (608) IN OPERATING POSITION 20

PART I.

INTRODUCTION.

INTRODUCTION.

Previous to the year 1918, no 20 gallon chemical fire extinguishers had been submitted to Underwriters' Laboratories for approval. During the years 1918 and 1919, five manufacturers submitted 20 gallon chemical extinguishers on wheels for inside use; four of the engines were of the loose stopple semi-inverting type; the other engine was of the break bottle type. This investigation is confined to the loose stopple type of device.

Although many operation tests have been run on all types of chemical extinguishers on wheels of the 40 gallon size and larger, it has not been found practicable to reason directly from one size of machine to another size, thus a new investigation became necessary for the 20 gallon extinguisher.

As the new device is intended for one man use, it is designed on the principle of an ordinary hand truck. The essential difference in exterior construction between the 20 gallon and the larger sizes of extinguishers on wheels, is that small iron wheels are used on the former,

located away from the center of gravity, while on the larger sizes large wooden wheels are used, located near the center of gravity. Because of this and other differences of construction, an investigation of structural features was necessary. Only the defects which were observed during the operation tests,were considered.

The machines under investigation were:

American La France, (473)
O.J.Childs, (585)
Ajax, (609)
Spero, (608)

PART II

O B J E C T S .

OBJECTS

The objects of this investigation are: to determine the relations of tank capacity, quantities of solution, soda, and acid, which seem to give the most satisfactory operation; and to suggest such changes as seem advisable to the extinguishers as submitted.

PART III

TESTS

CHAPTER I. TEST APPARATUS.

CHAPTER II. OPERATION TEST METHODS.

CHAPTER III. TEST PROCEDURE.

PART III.

CHAPTER I.

TEST APPARATUS.

TEST APPARATUS

America La France (473)

Total height of device	47½ inches
" width " "	22½ "
Wheels	18 " diameter
Tank diameter	12½ "
Distance from collar to water level	7¾ "
Total Tank capacity	20.19 gallons
Net " "	20.11 "
Bottle neck diameter	1 1/8 inches
Stopple "	7/16 "
Tipping Angle	12.8°

Strainer No. 6. Stamped galvanized ball-shaped strainer furnished with machine.
No filling indicator provided on tank.
Acid bottle capacity .254 gals. ≡ 3.9 Lbs acid

O.J.Childs (585)

Total height of device	48 inches
" width " "	
Wheels	18 " diameter
Tank diameter	12 "
Distance from collar to water level	7 3/8 "
Total Tank capacity	19.75 gallons
Net " "	19.61 "
Bottle neck diameter	1½ inches
Stopple "	7/8 "
Tipping Angle	13°

Strainer No.3. 1" pipe with 40-5/32" diameter holes.
Strainer No.4. Lead with 30-5/32" diameter holes, furnished by manf'.
Acid bottle capacity .28 gals. ≡ 4.2 Lbs. Acid

Ajax (609)

Total height of device	50½ inches
" width " "	24 "
Wheels	24 " diameter
Tank diameter	12 "
Distance from collar to water level	6 "
Total Tank capacity	19.4 gallons
Net " "	19.3 "
Bottle neck diameter	1½ inches
Stopple diameter	5/8 "
Tipping angle	17.7°

Strainer No.5. Copper disc furnished by the manf'.
Acid bottle capacity .30 gals ≡ 4.6 Lbs acid
Filling indicator bottom of cage, 14.33 gals

Spero (608)

Total height of device	37½ inches
" width of "	22½ "
Wheels	24 " diameter
Tank diameter	14 "
Distance from collar to water level	6 5/8 "
Total Tank capacity	20.3 gallons
Net " "	20.2 "
Acid bottle and stopple	same as (609)
Tipping angle	20°

Strainer No.1. Spero original, ¾" projection into tank
Strainer No. 2. Spero soldered, 48-5/32" dia. holes drilled.
No filling indicator provided.

PLATE I

AMERICAN LA FRANCE 20-GALLON EXTINGUISHER (473)

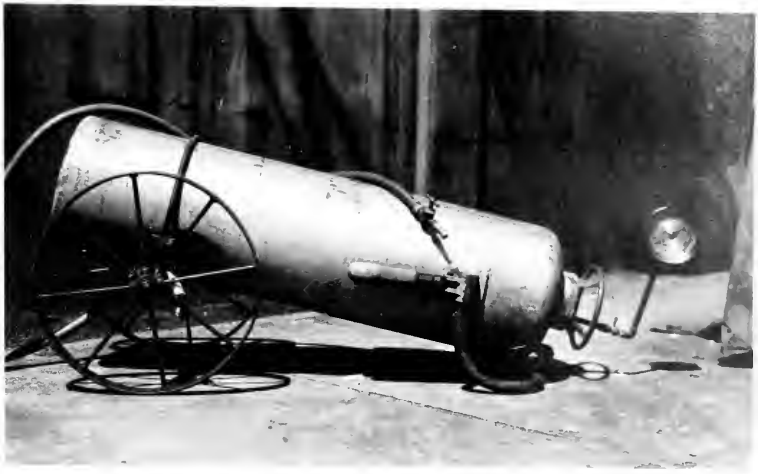


PLATE II

AMERICAN LA FRANCE (473) IN OPERATING POSITION.

PLATE III

O. J. CHILDS (585), EXTINGUISHER PARTS

PLATE IV

AJAX 20-GALLON CHEMICAL FIRE EXTINGUISHER (609)

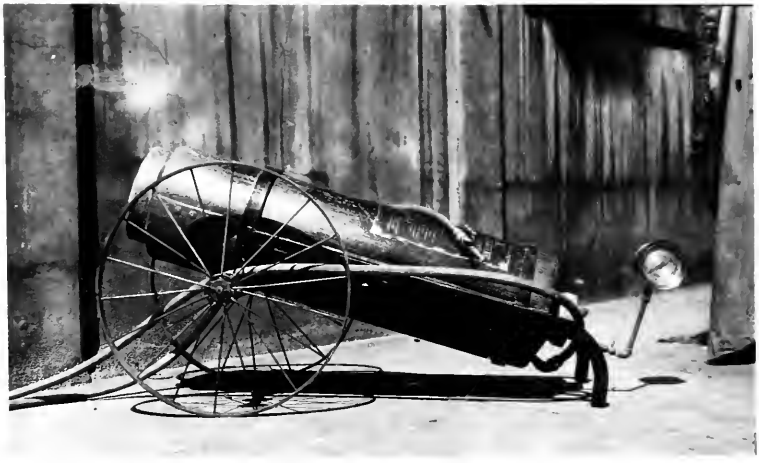


PLATE V

AJAX (609) IN OPERATING POSITION

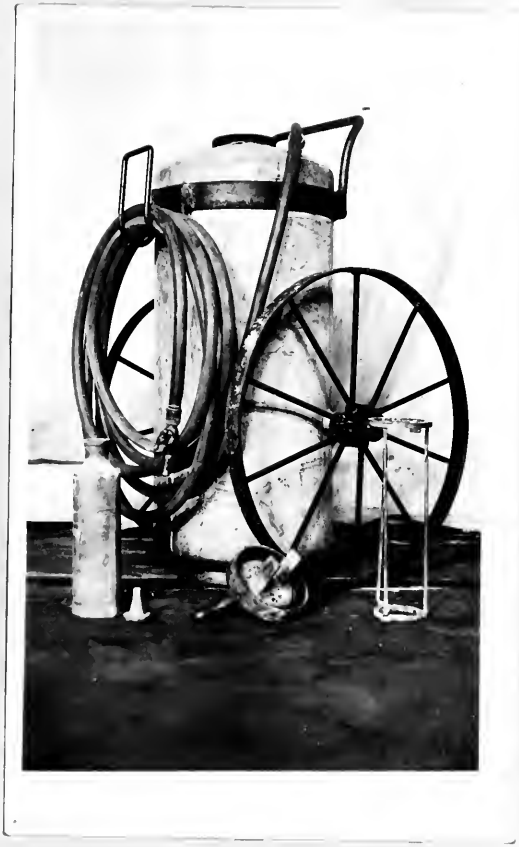


PLATE VI

SUPERIOR 150-GALLON CHEMICAL FIRE EXTINGUISHER (60 gal)

PLATE VII

SPERO (608) IN OPERATING POSITION

PART III.

CHAPTER II.

OPERATION TEST METHODS.

OPERATION TEST METHODS.

In the majority of tests, 17 gallons of water was poured into the extinguisher and the weighed amount of sodium bicarbonate was added. The mixture was stirred until the soda was thoroughly dissolved. A temperature reading of the solution was taken. The acid bottle, with the weighed quantity of acid was placed in its cage with the stopple in place, and the cap with gasket was screwed onto the collar. A 1/4 inch hole was tapped into the cap, a little off center, into which a 300 lb. Crosby gauge was screwed to obtain the tank pressure. Tests from March 21 to March 26, inclusive, were performed with 20 ft. of 1/4 inch patrol hose leading from cap to gauge. After March 27, 4 feet of patrol hose and 10 feet of 1/4 inch pipe were used from cap to gauge.

In the open nozzle test, the machine was tipped at a predetermined time; pressure readings were made every 10 seconds, range observations were made every 20 seconds, and stream samples were taken every 20 seconds. Method of taking stream samples was to collect in sample

bottles, the discharge from 1/8 inch cock tapped into nozzle. Time at which the solution in the tank was completely exhausted, that is, the time at which gas was emitted, was recorded as "gas".

In the closed nozzle test, the pressures were read every 10 seconds with the nozzle closed until a constant pressure was reached. The nozzle was then opened and the test continued with the same procedure as the open nozzle tests.

After completion of test, the tank residue was measured, and residue and stream samples were tested with litmus paper.

PART III.

CHAPTER III.

TEST PROCEDURE.

TEST PROCEDURE.

As stipulated by the Underwriters' Laboratories, the standard charge for a 20-gallon chemical extinguisher is 17 gallons. As a starting point for the series of operation tests, a machine was selected at random, 17 gallons of water was used with one-half the chemical charge specified for the standard 40 gallon machine, and an open nozzle test was run at 70 degrees Fahrenheit. This test was not entirely satisfactory, hence, from this point on, test conditions were varied to eliminate undesirable characteristics as they appeared.

The temperatures at which the tests were run were selected to include all ordinary conditions likely to be encountered in the field. 70 degrees Fahrenheit was recognized as being the ordinary temperature, 90 degrees Fehrenheit was selected as a common summer temperature, while 105 degrees Fahrenheit was thought to be the highest temperature apt to be reached inside the average building. A few low temperature tests were run to determine the effect of this condition which may occur in

a cold storage warehouse.

American-La France, (473)

The first test was run on the American LaFrance (473) with 17 gallons of water, 10 lbs. of soda, and 3-1/2 lbs. acid, at 70 degrees temperature with the nozzle open. With the maximum pressure obtained it was thought that under higher temperatures with nozzle closed, the pressure might be excessive. Consequently, in the next test, (473-2) the acid was decreased to 3 lbs. and a lower maximum was reached. In this test as in the initial test, the stream duration was over 5 minutes which showed too slow a discharge, therefore in the next test (473-3) the nozzle orifice was increased from 5/32 inch to 3/16 inch diameter, and again a 3-1/2 lb. acid charge was used. This showed a decrease in stream duration to 4-1/3 minutes. A series of tests, (473-8,4, 5,6, 7) were then run to determine the effect of nozzle size upon stream duration. These tests resulted in the adoption of a 7/32 inch diameter orifice when the American LaFrance type of nozzle is used.

In the test (473-7) an acid residue was obtained because the acid feed was too slow, hence, in test (473-9) the stopple was removed and an alkaline residue was obtained. As it is not feasible to have an acid bottle without a stopple, because sulphuric acid absorbs moisture and would in time overflow the bottle, a different method of accelerating acid feed was necessary. It was seen that the removal of a small guide soldered to the center of the cap would permit a greater travel of the stopple, and cause less obstruction to the acid flow. The next six tests were run with the stopple guide removed, at 70, 90, and 105 degrees Fahrenheit, open and closed nozzle with 3 lbs. of acid. In these tests, all but one of the residue was alkaline; namely, (473-12), an open nozzle 105 degrees Fahrenheit test, which gave an acid residue.

O. J. CHILDS (585)

The machine was first operated using the 1/4 inch Childs nozzle, furnished by the Manufacturer with 10 lbs. soda and 3 lbs. acid charge, as specified. Resulting stream

duration was too short and the residue was acid, showing that the nozzle orifice was too large. A 7/32 inch American LaFrance nozzle was used in the next seven succeeding tests. Tests (585-2,3,4) were open nozzle with 3 lbs. acid at 70, 89, 104 degrees Fahrenheit, respectively. Residue of test (585-4) was acid and it was decided to see in tests (585-5,6,7,8) if decreasing the acid charge to 2-1/2 lbs. would eliminate acid residue and still give satisfactory pressures. An acid residue was again obtained on the 105 degree open nozzle test (585-8). The decrease in the acid charge did not eliminate acid residue, but the pressures obtained were lower, although still satisfactory. In these tests the strainer used left a tank residue of 3 fluid ounces; a new strainer furnished by the Manufacturer and leaving a residue of 16 fluid ounces, was used in all succeeding tests. In tests (585-13, 14,15) which were 70, 105, 90 degrees Fahrenheit with 2-1/2 lbs. acid, the residue was alkaline. Closed nozzle tests were then run at 70 and 105 degrees Fahrenheit with

2-1/2 lbs. acid. In the 70 degrees Fahrenheit test (585-16), the duration was 4 minutes with a gas pressure of 21 lbs. which seems too low. A 105 degrees Fahrenheit open nozzle test with 3 lbs. acid (585-18) was satisfactory as to pressure, duration and range. The 105 degrees Fahrenheit closed nozzle test (585-19) on 3 lbs. acid was run and the maximum was too high, being in excess of 300 lbs.

Tests (585-9 and 12) were run with the Childs' nozzle and acid charges of 3 and 2-1/2 lbs., respectively, but the stream durations were too short for 70 degrees Fahrenheit tests. Consequently, if the Childs type of nozzle is to be used, a smaller diameter orifice than 7/32 inch should be used.

AJAX-609

The first six tests were run with a copper disk strainer with charges of 10 lbs. soda and 3 lbs. acid. In test (609-5) at 105 degrees Fahrenheit with closed nozzle, the pressure was too high, consequently tests were run with a 2-1/2 lb. acid charge. In test (609-14) at 72 degrees Fahrenheit with closed nozzle, the gas point was

too low, showing that 2-1/2 lbs. is insufficient. Further tests were run at low temperatures, open and closed nozzle with 3 and 2-1/2 lbs. acid charge. Because of the low gas pressures with the 2-1/2 lbs. acid, it is deemed necessary to use 3 lbs. of acid. If the tank capacity of the machine is increased to its rated capacity or larger, an identical test to (609-5) will not give a prohibitive maximum.

SPERO-608.

The machine as furnished had a 3/16 inch nozzle, and was operated for the first test with 10 lbs. soda, 3-1/2 lbs. acid. Due to a broken acid bottle cage, the test was erratic, but it indicated too long a stream duration. The orifice was drilled to 7/32 inch diameter and a 3 lb. acid charge test was run. This gave satisfactory pressure and duration, and a closed nozzle test under same conditions gave satisfactory operation. However, the residue left in the tank was 48 fluid ounces, consequently the strainer was soldered and 48-5/32 inch holes drilled into it for further tests. The outlet elbow which initially pro-

jected into the tank about 7/8 inch was sawed off to project 3/8 inch into the tank which reduced the residue to about 22 fluid ounces.

70, 90 and 105 degrees Fahrenheit open and closed nozzle tests (608-4,5,15,3,16,14) were run as normal operation tests with 3 lbs. acid. Five more tests (608-24,22,19,21,20) were run with a 2-1/2 lb. acid charge. 90 degrees, and 105 degrees open and closed and a 70 degree open. Open and closed nozzle tests with 3 lbs. acid charge were run at low temperatures, (608-31,30).

Tests (608-18,27-26, 25,17) were made to determine the effect of varying soda charge. They were run at 70 degrees closed nozzle, 3 lbs. acid with the soda charge at 6,8,10,12,13,5 5 lbs. made up to 17 gallons solution. The 13.5 lbs. soda charge was intended to show the effect of having a saturated solution.

Tests (608-29,10-8,28-,26,3,11,12) were made to determine the effect of varying the solution quantity, using constant acid and soda charges of 3 lbs. and 10 lbs., respectively. These tests were run at 70 degrees Fahrenheit

with open and closed nozzle.

Tests (608-6,7) were run as duplicates of (608-8,10) at 70 degrees open nozzle, 3 lbs. acid with 17, and 17-1/2 gallons solution. These tests gave acid residue, and tests (608-8,10) gave alkaline. The explanation for this difference is due to the fact that a section of hose was used between cap and gauge which held some of the acid solution during the time of high pressure and released when pressure in tank lowered to atmospheric.

An open and closed 70 degrees Fahrenheit test (608-9,23) was run with the acid bottle full, containing 4 lbs. 7 ounces of acid to see what effect this overcharging would have with a normal 10 lb. charge of soda. The pressure reached in the closed nozzle test was so high that with a higher temperature the maximum pressure would be excessive.

One test was run (608-13) with 7-1/2 lbs. soda, 2-1/2 lbs. acid to determine the effect of proportionately reducing the chemical charges.. The pressure at gas was too low, therefore in the other 2-1/2 lbs. acid tests it was decided to have a greater soda charge.

PART IV

D A T A A N D C U R V E S

	Test			Charge			Nozzle		Pressure			Stream---		Residue					Remarks	Date
Data Sheet	Test No.	Type	Degs Fahr	Water Gal	Soda lbs	Acid lbs	Diameter Inches	Type	Max	At Gas	Secs. to Maximum	Duration Secs	Range Feet	Samples	Fl.oz.	Char-acter	Fl.oz. Acid in bottle	Strainer		
1	1	O.	70	17	10	3½	5/32	A.	124	45	50	510	60-40	1k	14	Alk	2	6		1/25/19
2	2	O.	70	17	10	3	5/32	A.	114	54	50	540	55-55	Alk	14	Alk		6		"
1	3	O.	72	17	10	3½	3/16	A.	120	46	35	360	65-40	1k	15	Alk		6		1/27
3	4	O.	70	17	10	3	1/8	A.	132	35	35	460	45-35	Alk	14	Alk	2	6		2/6
3	5	O.	70	17	10	3	5/16	A.	103	40	35	250	55-40	Alk	14	Neu	2	6		"
4	6	O.	70	17	10	3	5/32	A.	106	34	30	380	60-40	Alk	13	Alk	2	6		2/8
4	7	O.	70	17	10	3	7/32	A.	90	29	30	210	60-45	1k	15	Acd	2	6		"
4	8	O.	70	17	10	3	1/4	A.	66	40	30	130	60-40	1k	13	Acd	2	6		"
2	9	O.	70	17	10	3	7/32	A.	109	35	35	[illegible]	50-40	1k	12	Alk	2	6	No Stopple	2/10
5	10	O.	70	17	10	3	7/32	A.	88	39	50	300	50-45	1k	13	Alk	2	6	No Guide	"
5	11	O.	90	17	10	3	7/32	A.	97	48	30	190	50-50	1k		Alk		6	" "	"
5	12	O.	105	17	10	3	7/32	A.	111	56	35	170	50-45	1k	12	Acd	2	6	" "	"
6	13	O.	90	17	10	3	7/32	A.	242	55	60	320	55-5[illegible]	1k	13	Alk	2	6	" "	"
6	14	O.	70	17	10	3	7/32	A.	177	26	70	350	55-40	Alk	15	Alk	2	5	" "	3/16
6	15	O.	105	17	10	3	7/32	A.	251	38	70	210	50-40	Alk	14	Alk	2	6	" "	5/29

Date No.	Test No.	Type	Temp °F	Water gals	Soda Lbs	Acid Lbs	Nozzle dia. Inches	Make	Max. Pres	Gas Pres	Time to Max Seconds	Duration Stream Secs.	Range Feet	Stream Samples	Residue fl.oz.	Character	Acid res. in bottle fl.oz.	Strainer	Remarks	Date of Test
11	1	O.	70	17	10	3	1/4	C.	99	41	20	140	65-50	Alk	3	Acid	3	3		2/15/19
7	2	O.	70	17	10	3	7/32	A.	130	37	20	200	65-45		3	Alk.	3	#3		2/17/19
7	3	O.	89	17	10	3	7/32	A.	145	51	20	170	65-50	"	3	"	3	#3		"
7	4	O.	104	17	10	3	7/32	A.	157	54	20	160	60-45	"	3	Acid	3	3		"
10	5	O.	71	17	10	2½	7/32	A.	158	50	10	200	65-45	"	3	Alk	3	3	No Stopple	"
8	6	O.	70	17	10	2½	7/32	A.	113	51	20	210	60-45	"	3	"	3	#3		"
8	7	O.	90	17	10	2½	7/32	A.	134	40	20	180	65-50	"	3	"	3	#3		"
8	8	O.	105	17	10	2½	7/32	A.	139	44	20	170	65-50	"	3	Acid	3	3		"
11	9	O.	70	17	10	3	7/32	C.	113	45	20	150		"	3	Alk.	3	#3	1" Board	2/18
10	10	O.	70	17	10	2	7/32	C.	50	50	210	210		"		Acid		#3	1"B Stpl.spec.	"
	11	Test Unsatisfactory																		
10	12	O.	72	17	10	2½	7/32	C.	96	33	20	160		"		Alk.		#4	2" Block	2/19
9	13	O.	70	17	10	2½	7/32	A.	107	32	30	190		"	16	"		#4	1" Board	"
9	14	O.	105	17	10	2½	7/32	A.	150	60	20	150		"	16	"		#4	1"	"	"
9	15	O.	90	17	10	2½	7/32	A.	124	41	20	160		"	16	"		#4	1" "	"
12	16	C.	70	17	10	2½	7/32	A.	205	21	35	240		"	16	"		#4	1" "	"
12	17	C.	105	17	10	2½	7/32	A.	274	34	40	190		"	16	"		#4	1" "	"
11	18	C.	105	17	10	3	7/32	A.	147	56	20	130	55-50	"	16	"	3	#4	1" "	2/20
12	19	C.	105	17	10	3	7/32	A.	309	42	40	190		"	16	Neut.	3	4	1" "	"

Note: 'A' is American La France, 'C' is O.J.Childs.

Data Sheet	Test: Test No.	Test: Type	Degs Fahr	Charge: Water Gal	Charge: Soda Lbs	Charge: Acid Lbs	Nozzle: Diameter Inches	Nozzle: Type	Pressure: Max.	Pressure: Gas	Pressure: Secs. to Maximum	Stream: Duration Secs.	Stream: Range Feet	Stream: Samples	Residue: Fl.oz.	Residue: Character	Strainer	Remarks	Date
14	1	C.	70	17	10	3	7/32	A.	112	49	50	210	60-45	Alk	3	Alk	#5		3/3/19
14	2	C.	90	17	10	3	7/32	A.	144	53	50	190	65-45	Alk	2	Alk	#5		"
14	3	C.	105	17	10	3	7/32	A.	156	60	30	180	60-45	Alk	3	Alk	#5		"
16	4	C.	90	17	10	3	7/32	A.	248	37		250	60-45	Alk	3	Alk	5	Erratic.	"
16	5	C.	105	17	10	3	7/32	A.	290	36	40	230	60-40	Alk	3	Alk	#5		"
16	6	C.	70	17	10	3	7/32	A.	210	24	40	270	60-40	Alk	3	Alk	#5		"
13	7	C.	70	17	10	3	7/32	A.	151	44	30	150	55-45	Alk	3	Alk	#2		3/6.
17	8	C.	70	17	10	3	7/32	A.	236	32	40	250	55-40	Alk	3	Alk	#2		"
13	9	C.	90	17	10	3	7/32	A.	125	60	20	170	60-50	Alk	2½	Alk	2		"
13	10	C.	105	17	10	3	7/32	A.	131	54	25	130	50-50	Alk	3	Alk	#2		"
15	11	C.	90	17	10	2½	7/32	A.	130	[illegible]	20	150	50-45	Alk	2	Alk	#2		3/20
15	12	C.	105	17	10	2½	7/32	A.	133	16	20	170	65-50	Alk	3	Alk	#2		
15	13	C.	72	17	10	2½	7/32	A.	107	41	50	180	55-45	Alk	3	Alk	#2		"
18	14	C.	72	17	10	2½	7/32	A.	220	26	40	240	60-40	Alk	3	Alk	#2		"
18	15	C.	50	17	10	2½	7/32	A.	97	25	30	230	55-45	Alk	5	Alk	#2		"
17	16	C.	50	17	10	3	7/32	A.	87	33	50	220	60-40	Alk	5	Alk	#2		3/3
17	17	C.	50	17	10	3	7/32	A.	173	26	30	260	55-35	Alk		Alk	None	Cap leaks.	"
18	18	C.	[illegible]	17	10	2½	7/32	A.	161	18	35	200	60-35	Alk		Alk	#2		3/29 3/31

	Test			Charge			Nozzle		Pressure		--Stream--			Residue					Remarks	
Data Sheet	Test No.	Type	Dege Fahr	Water Gal	Soda Lbs	Acid Lbs	Diameter Inches	Type	Maximum	At Gas	Sec to Max	Duration Secs	Range Feet	Samples	Fl.oz.	Character	Strainer	Bottle		Date
19	1	C.	70	17	10	3½	3/16	A.	122	65				1k	40	1k	#1	Sp	Erratic	1/30/19
19	2	C.	70	17	10	3	7/32	A.	111	49	35	190	55-40	1k	48	1k	1	Sp	Note: * indicates quantity of solution.	"
22	3	C.	69	17	10	3	7/32	A.	178	54	80	230	55-55	1k	48	1k	1	Sp		"
20	4	C.	70	17	10	3	7/32	A.	115	44	50	200	60-40	1k	22	1k	2	Sp		2/1
20	5	C.	90	17	10	3	7/32	A.	137	54	20	180	50-50	1k	20	Alk	2	Sp		"
28	6	C.	70	17	10	3	7/32	A.	110	36	25	210		1k	24	cd	2	Aj		3/21
28	7	C.	70	*17½	10	3	7/32	A.	97	45	40	200	60-45	1k	22	cd	2	Aj		3/22
25	8	C.	70	17	10	3	7/32	A.	93	43	50	200	60-45	1k	22	1k	2	Aj		3/22
27	9	C.	70	17	10	4.4	7/32	A.	145	38	30	170	55-	1k	23	cd	2	Aj		"
30	10	C.	70	*17	10	3	7/32	A.	130	46	25	190		Alk	22	Alk	2	Aj		"
26	11	C.	70	*18	10	3	7/32	A.	212	31	50	230	50-40	1k	20	1k	2	Aj		"
26	12	C.	70	*19	10	3	7/32	A.	236	32	50	240	50-40	1k	22	cd	2	Aj		"
30	13	C.	71	17	7½	2½	7/32	A.	141	27	70	230	55-40	1k		Alk	2	Aj	Erratic	3/24
22	14	C.	105	17	10	3	7/32	A.	273	50	50	180	55-45	1k	22	1k	2	Aj		"
20	15	C.	105	17	10	3	7/32	A.	148	63	30	150	50-50	Alk	22	1k	2	Aj		"
22	16	C.	90	17	10	3	7/32	A.	262	45	60	190	55-45	Alk	22	1k	2	Aj		"
30	17	C.	70	*17	13½	5	7/32	A.	280	57	Nozzle blew off Hose						2	Aj		"
29	18	C.	72	17	6	3	7/32	A.	161	37	40	210	50-40	1k		cd	2	Aj		"
21	19	C.	105	17	10	2½	7/32	A.	125	45	30	170	55-50	1k	22	1k	2	Aj		3/26
21	20	C.	70	17	10	2½	7/32	A.	105	55	10	210	55	1k	22	1k	2	Aj	Gage Brk	"
23	21	C.	105	17	10	2½	7/32	A.	227	39	50	130	55-50	1k	22	1k	2	Aj		"
23	22	C.	90	17	10	2½	7/32	A.	210	Coupling blew off gauge hose. No pres.ob.										"
27	23	C.	70	17	10	4.4	7/32	A.	265	55	40	170	55-45	1k	22	cd	2	Aj		3/27
21	24	C.	90	17	10	3	7/32	A.	122	46	35	170	65-65	1k	22	1k	2	Aj		"
29	25	C.	70	*17	12	3	7/32	A.	241	41	40	190	65-45	1k	22	1k	2	Aj		3/29
26	26	C.	69	*17	16	3	7/32	A.	200	23	40	210	60-40	1k	22	1k	2	Aj		"
29	27	C.	70	*17	8	3	7/32	A.	178	27	50	210	60-40	1k	22	1k	2	Aj		"
25	28	C.	70	*18	10	3	7/32	A.	119	42	20	200	60-45	1k	22	1k	2	Aj		"
25	29	C.	70	*16½	10	3	7/32	A.	115	47	25	130	60-45	Alk	22	Alk	2	Aj		3/31
24	30	C.	46	17	10	3	7/32	A.	158	27	40	240	60-40	1k	22	1k	2	Aj		"
24	31	C.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	A.	104	54	25	210	55-40	1k	22	1k	2	Aj		

Data Sheet No. 3.

		A.L.P. (473)			C.J.C. (565)			Ajax (609)			Sparo (608)			Average		
	Temp.	Max.	Gas	Duration	Max.	Gas	Duration	Max.	Gas	Dur.	Max.	Gas	Dur.	Max.	Gas	Dur.
Open	70	88	39	200	120	37	200	117	46	200	113	44	200	111	42	200
	90	97	48	190	145	51	170	140	57	180	137	54	180	132	53	180
	105	111	56	170	157	54	160	159	62	170	143	63	160	147	59	166
Closed 5 Lbs. Acid	70	177	26	230				210	24	270	178	54	230	188	51	243
	90	242	33	220				248	37	250	268	45	190	251	38	220
	105	251	38	210	309	42	190	290	56	230	273	50	180	281	41	202
Open	70				110	32	200	107	41	180	105	35	200	107	36	193
	90				129	41	180	130	46	170	122	48	170	127	45	173
	105				145	52	160	132	56	150	135	46	170	137	51	160
Closed 24 Lbs. Acid	70				205	21	240	220	26	240				213	24	240
	90										210			210		
	105				274	34	190				237	39	180	256	37	185

Remarks: Water 17 Gals.

Soda 10 Lbs.

Tests No. 1,3. Ex. No.473. Data Sheet No. 1.

Normal Operation Tests Open Nozzle. Test by .I.T.'19.

A.L.F. Nozzle, 25'-2" Hose. Strainer No. 6.

Stream Samples 1k. Tank Residue 15 fl.oz. 1k.

Water 17 gals. Soda 10 Lbs. Acid 3½ Lbs. Temp. 1, 70°; 2, 72°

#1,- 5/32" Nozzle

Time	Pres	Range
10	55	
20	109	65
30	120	
40	118	
50	107	
60	98	60
70	94	
80	89	
90	84	
100	80	
110	76	
120	74	55
130	71	
140	68	50
150	65	
160	63	45
170	60	
180	58	
190	56	
200	55	40
210	53	
220	52	
230	50	
240	48	
250	47	
260	45	Gas
270	40	
280	33	
290	22	
300	16	
310	11	
320	6	

#2,- 3/16" Nozzle

Time	Pres	Range.
10	95	
20	141	60
30	134	
40	131	
50	116	55
60	111	
70	105	50
80	99	
90	95	
100	89	
110	85	
120	81	
130	78	45
140	75	
150	72	
160	69	
170	67	
180	65	
190	63	
200	61	
210	59	
220	57	
230	56	
240	54	40
250	52	
260	51	
270	50	
280	49	
290	47	
300	45	Gas
310	43	
320	37	
330	30	
340	22	
350	15	
360	10	
370	6	

Tests No. 2,9. Ex. No. 473. Data Sheet No. 2.

Normal Operation Tests Open Nozzle Test by A.L.T.'12.

A.L.F. Nozzle, 25' A.L.F. 1" Hose. Strainer No. 6.

Stream Samples 1k. Tank Residue 12 fl.oz. 1k.

Water 17 gals Soda 10 Lbs. Acid 8 Lbs. Sol. Temp. 70°F.

'12. 5/32" Nozzle			'9. 7/32" Nozzle No Stopple		
Time	Pres	Range	Time	Pres	Range
10	85		10	90	
20	96		20	107	60
30	114	65	30	97	
40	104		40	90	
50	95		50	81	
60	90		60	75	
70	84		70	71	55
80	79	50	80	66	
90	75		90	61	50
100	71		100	59	
110	68		110	54	
120	65		120	51	
130	63		130	49	45
140	59		140	47	
150	58		150	45	
160	56		160	43	
170	54		170	41	
180	53	45	180	39	
190	51		190	38	
200	49		200	37	40
210	48		210	35	Gas
220	46		220	31	
230	45	40	230	24	
240	43		240	15	
250	42		250	11	
260	41		260	3	
270	40				
280	39				
290	38				
300	37	35			
310	36				
320	35				
330	34				
340	32	Gas			
350	27				
360	21				
370	16				
380	10				
390	6				

Tests No. 5,4. Ex. No. 473. Data Sheet No. 3.

Normal Operation Tests Open Nozzle Tests by A.L.F.'19.

A.L.F. Nozzle, 25' A.L.F. ¾" Hose Strainer No. 6.

Stream Samples Alk. Tank Residue 14 fl.oz. #6 neutral-¼ alk.

Water 17 gals Soda 10 Lbs. Acid 5 Lbs. Solution Temp. 70°F.

#5. 3/16" Nozzle			#4. 1/8" Nozzle			#4, cont'		
Time	Pres	Range	Time	Pres	Range	Time	Pres	Range
10	88		10	77		310	46	
20	92		20	108	45	320	45	
30	101	55	30	121		330	45	
40	97		40	128		340	44	
50	92		50	116		350	43	
60	84		60	108		360	42	
70	80		70	100	40	370	41	
80	76	50	80	95		380	41	
90	72		90	91		390	40	
100	68		100	86		400	39	
110	65	45	110	82		410	38	
120	62		120	80		420	38	
130	59		130	76		430	37	
140	57		140	74		440	36	
150	54		150	72		450	35	
160	52		160	69		460	33	Gas
170	50		170	67		470	28	
180	49		180	65		480	25	
190	47	40	190	65		490	22	
200	46		200	61		500	19	
210	44		210	59		510	16	
220	43		220	58		520	14	
230	41		230	56	35	530	12	
240	40		240	54		540	10	
250	39		250	53		550	8	
260	37	Gas	260	52		560	6	
270	30		270	51				
280	23		280	50				
290	16		290	49				
300	9		300	47				

Note: Gauge read 3" high.
Pressure shown are corrected.

Tests No. 6,7,8. Ex No. 473. Data Sheet No. 4.

Normal Operation Tests Open Nozzle Tests by A.L.T.'19.

A.L.F. Nozzle, 25' A.L.F. ½" Hose. Strainer No. 5.

Stream Samples Alk. Tank Residue 12 fl.oz. #6, alk.- 7,8, acid.

Water 17 gals Soda 10 Lbs. Acid 3 Lbs. Vol. Temp. 70°F.

#6. 5/32" Nozzle			#7. 7/32" Nozzle			#8. 9/32" Nozzle		
Time	Pres	Range	Time	Pres	Range	Time	Pres	Range
10	74		10	65		10	83	50
20	105	55	20	84	60	20	79	
30	106		30	90		30	66	30
40	100		40	89		40	85	
50	95		50	82		50	80	
60	89		60	75		60	75	55
70	81	50	70	72	55	70	70	
80	76		80	69		80	65	50
90	72		90	65		90	61	
100	68		100	62		100	57	
110	64		110	59	50	110	54	
120	61		120	56		120	51	
130	58		130	53		130	49	
140	55	45	140	51		140	47	45
150	53		150	49		150	45	
160	51		160	46		160	43	40
170	50		170	45		170	41	
180	48		180	43	45	180	40	Gas
190	47		190	42		190	35	
200	45	40	200	40		200	25	
210	44		210	38	Gas	210	16	
220	42		220	31		220	6	
230	41		230	21				
240	40		240	13				
250	39		250	6				
260	38							
270	37	Gas						
280	34							
290	25							
300	19							
310	14							
320	8							

Tests No. 10,11,12 Ex. No.473. Data Sheet No. 5.

Normal Operation Tests Open Nozzle Tests by A.I.T.'19.

7/32" Nozzle, 25'-½" Hose A.L.F. Strainer No. 6.

Stream Samples Alk. Tank Residue 12 Fl.oz. #10,11 Alk. #12 acid

Water 17 gals Soda 10 Lbs. Acid 3 Lbs. No Stopple Guide

#10, 70°F. #11, 90°F. #12, 105°F.

Time	Pres	Range	Time	Pres	Range	Time	Pres	Range
10	59		10	83		10	75	
20	79	60	20	89	60	20	102	60
30	88		30	97		30	111	
40	89		40	96		40	111	
50	79		50	92		50	107	
60	75		60	88		60	99	
70	71	55	70	84	55	70	93	55
80	67		80	79		80	88	
90	64		90	75		90	83	50
100	61	50	100	73		100	79	
110	58		110	70	50	110	75	
120	55		120	66		120	71	
130	52		130	63		130	67	45
140	49		140	60		140	64	
150	46		150	57		150	61	
160	45	45	160	54		160	59	
170	43		170	52		170	56	Gas
180	42		180	51		180	49	
190	40		190	49	Gas	190	36	
200	39	Gas	200	37		200	24	
210	35		210	26		210	14	
220	27		220	17		220	7	
230	19		230	9				
240	11							
250	4							

Tests No. 14,13,15. Ex. No.473. Data Sheet No. 6.

Normal Operation Tests Closed Nozzle. Tests by A.I.T.'19.

7/32" A.L.F. Nozzle, 25' A.L.F. ½" Hose. Strainer No.6.

Stream Samples Alk. Tank Residue Alk. 15 fl.oz.

Water 17 gals Soda 10 Lbs. Acid 3 Lbs.

#14, 70°F. No Stopple guide			#13, 90°F. No Stopple guide			#15, 105°F. No Stopple guide		
Time	Pres	Range	Time	Pres	Range	Time	Pres	Range
10	70		10	80		10	97	
20	115		20	170		20	164	
30	144		30	208		30	208	
40	161		40	219		40	228	
50	169		50	228		50	241	
60	174		60	233		60	247	
70	177	Open	70	236		70	251	Open
80	117	55	80	238		80	153	60
90	95		90	240		90	127	
100	82		100	241		100	108	55
110	73		110	242		110	97	
120	66		120	242		120	88	50
130	60	50	130	242		130	80	
140	56		140	242	Open	140	75	
150	52	45	150	153	55	150	71	
160	48		160	124		160	66	
170	46		170	103	50	170	61	45
180	44		180	91		180	58	
190	42		190	82		190	55	
200	40		200	74		200	52	
210	38		210	69		210	51	
220	36	40	220	64		220	49	
230	34		230	60	45	230	47	
240	33		240	56		240	45	
250	32		250	53		250	43	
260	31		260	51		260	42	
270	30		270	49	40	270	41	40
280	29		280	46		280	38	Gas
290	28		290	44		290	31	
300	27	Gas	300	42		300	21	
310	25		310	40		310	15	
320	19		320	39		320	8	
330	13		330	38				
340	6		340	36				
350			350	34	35			
			360	33				
			370	31	Gas			
			380	25				
			390	15				
			400	9				

Tests No. 2,3,4. Ex. No. 585. Data Sheet No. 7

Normal Operation Tests Open Nozzle. Test by A.I.T.'19.

7/32"A.L.F.Nozzle,25'A.L.F. ½" Hose. Strainer No. 3.

Stream Samples Alk. Tank Residue 3 fl.oz. #2,3, alk. #4, acid.

Water 17 gals Soda 10 Lbs, Acid 3 Lbs.

#2, 70°F.			#3, 89°F			#4, 104°F.		
Time	Pres	Range	Time	Pres	Range	Time	Pres	Range
10	97		10	110		10	118	
20	120	65	20	145	65	20	157	60
30	113		30	137		30	144	
40	99		40	125		40	128	
50	84		50	111	60	50	114	55
60	76	60	60	101		60	100	
70	70		70	90		70	91	50
80	65		80	83		80	84	
90	60		90	75		90	78	
100	57	55	100	74		100	74	
110	53		110	70		110	71	45
120	51		120	66		120	67	
130	49		130	63		130	64	
140	47		140	61	55	140	61	
150	45		150	59	50	150	59	
160	43		160	56	Gas	160	54	Gas
170	42	45	170	51		170	43	
180	40		180	41		180	32	
190	39		190	28		190	20	
200	37	Gas	200	19		200	11	
210	30		210	10		210	4	
220	21		220	4				
230	13							
240	6							

Tests No. 6,7,8. Ex. No. 585. Tests by A.I.T.'19

Normal Operation Tests Open Nozzle Data Sheet No. 8.

7/32" A.L.F. Nozzle, 25' A.L.F. ½"Hose. Strainer No. 3.

Stream Samples Alk. Tank Residue 3 fl.oz. #6,7, alk. #8 alk.

Water 17 gals. Soda 10 Lbs. Acid 2½ lbs.

#6, 70°F			#7, 90°F			#8, 105°F.		
Time	Pres	Range	Time	Pres	Range	Time	Pres	Range.
10	78		10	110		10	110	
20	118	60	20	134	65	20	139	65
30	104		30	118		30	126	
40	87		40	103	60	40	107	
50	75		50	88		50	91	
60	67		60	77		60	80	60
70	61		70	71	55	70	73	
80	56	55	80	66		80	69	
90	52		90	61		90	64	55
100	49		1 00	58		100	60	
110	46		110	54		110	57	50
120	44	50	120	51	50	120	54	
130	42		130	49		130	51	
140	40		140	47		140	49	
150	39		150	45		150	47	
160	37	45	160	43		160	45	
170	36		170	42		170	44	Gas
180	34		180	40	Gas	180	39	
190	33		190	35		190	30	
200	32		200	27		200	20	
210	31	Gas	210	18		210	11	
220	25		220	10		220	5	
230	19		230	3				
240	11							
250	5							

Tests No. 13,15,14. Ex. No. 585. Data Sheet No. 9.

Normal Operation Tests Open Nozzle. Test by A.I.T.'19.

7/32" A.L.F. Nozzle, 25' A.L.F. ½" Hose. Strainer No. 4.

Stream Samples Alk. Tank Residue 16 fl.oz. Alk.

Water 17 gals Soda 10 Lbs. Acid 2½Lbs. 1"board under handle.

#13, 70°F			#15, 90°F			#14, 105°F		
Time	Pres	Range	Time	Pres	Range	Time	Pres	Range.
10	75		10	97		10	90	
20	107		20	124		20	150	
30	98		30	112		30	145	
40	81		40	96		40	133	
50	70		50	84		50	118	
60	63		60	75		60	104	
70	58		70	70		70	94	
80	52		80	64		80	86	
90	49		90	60		90	80	
100	46		100	56		100	76	
110	44		110	53		110	73	
120	42		120	50		120	69	
130	41		130	48		130	64	
140	39		140	46		140	62	
150	38		150	44		150	60	Gas
160	35		160	43		160	50	
170	35		170	41		170	40	
180	34		180	40	Gas	180	32	
190	32	Gas	190	36		190	24	
200	30		200	30		200	16	
210	25		210	21		210	9	
220	20		220	17				
230	14		230	12				
240	9		240	5				

Tests No. 12,10,5. Tx. No. 585. Data Sheet No. 10.

Normal Operation Tests Over Nozzle. Test by A.I.T.'19.

Stream Samples Alk. Tank residue #12,5 Alk. #12 Acid.

Water 17 gals Soda 10 Lbs Acid 2½ Lbs. 25'-½" Hose.

#12, 72°F. reg. stopple 2" block under handle. Str. #4 7/32" Childs nzzle			#10, 70°F. special stopple 1" board under handle. Str. "3. 7/32" Childs.			#5, 71°F. no stopple Strainer No.3. 7/32"A.L.T.nozzle.		
Time	Pres	Range	Time	Pres	Range	Time	Pres	Range.
10	70		10	5		10	158	
20	96		20	11		20	118	65
30	84		30	16		30	89	
40	72		40	20		40	76	60
50	62		50	23		50	69	
60	56		60	25		60	64	55
70	52		70	27		70	58	
80	47		80	31		80	54	50
90	45		90	34		90	50	
100	42		100	36		100	48	45
110	41		110	38		110	46	
120	39		120	39		120	44	
130	37		130	40		130	43	
140	35		140	40		140	40	
150	35		150	41		150	38	
160	33	Gas	160	42		160	36	
170	30		170	44		170	34	
180	26		180	44		180	33	
190	21		190	44		190	31	
200	15		200	49		200	30	Gas
210	8		210	50	Gas	210	27	
220	3		220	44		220	21	
			230	36		230	13	
			[illegible]	[illegible]		240	7	
			250	18				
			260	10				
			270	2				

Tests No. 18,9,1 Ex. No. 595. Data Sheet No. //.

Normal Operation Tests Open Nozzle. Tests by A.I.T.'19.

Stream Samples Alk. Tank Residue, #18,9 alk. #1 acid.

Water 17 gals. Soda 10 Lbs. Acid 8 Lbs. 25'A.L.F.¾" Hose

#18, 105°F 7/32" A.L.F nozzle Strainer No. 4. 1" board under hdl.			#9, 70°F 7/32" Childs nozzle Strainer No. 3. 1" board under hdl.			#1, 70°F ¼" Childs nozzle Strainer No. 3.		
Time	Pres	Range	Time	Pres	Range	Time	Pres	Range
10	112		10	80		10	85	
20	147	65	20	113		20	99	65
30	139		30	104		30	90	
40	125		40	89		40	77	60
50	110	60	50	79		50	68	
60	97		60	72		60	64	
70	88		70	67		70	59	
80	81		80	62		80	56	55
90	76		90	58		90	52	
100	72	55	100	55		100	49	
110	68		110	52		110	47	
120	64	50	120	50		120	45	50
130	62		130	49		130	43	
140	60		140	47		140	41	Gas
150	58		150	45	Gas	150	30	
160	56	Gas	160	39		160	17	
170	45		170	30		170	6	
180	35		180	20		180		
190	25		190	15				
200	18		200	4				
210	10							
220	4							

Tests Nos. 19,16,17. Ex. No. 585. Data Sheet No. 12.

Normal Operation Tests Closed Nozzle. Test by A. L. T. '19.

7/32" A.L.F. Nozzle, 25' A.L.F.½" Hose. Strainer No. 4.

Stream Samples Alk. Tank Residue 16 fl.oz. #19,neutral.#16,17 alk.

Water 17 gals. Soda 10 Lbs. 1" board under handle.

#19, 105°F Acid 3Lbs. #16, 70°F. Acid 2½ Lbs. #17, 105°F Acid 2½ Lbs.

Time	Pres	Range	Time	Pres	Range	Time	Pres	Range
10	120		10	90		10	100	
20	238		20	170		20	220	
30	283		30	196		30	260	
40	300		40	202		40	272	
50	307		50	204		50	274	
60	309	Open	60	205		60	273	
70	315		70	205		70	271	
80	142		80	204	Open	80	270	Open
90	113		90	112		90	144	
100	98		100	82		100	104	
110	88		110	66		110	87	
120	81		120	59		120	78	
130	74		130	54		130	72	
140	71		140	47		140	66	
150	67		150	44		150	61	
160	64		160	42		160	58	
170	60		170	40		170	54	
180	58		180	27		180	51	
190	54		190	36		190	48	
200	52		200	35		200	45	
210	50		210	33		210	44	
220	48		220	31		220	42	
230	46		230	30		230	40	
240	45		240	29		240	39	
250	42	Gas	250	27		250	38	
260	36		260	26		260	36	
270	26		270	25		270	34	Gas
280	21		280	24		280	31	
290	15		290	23		290	25	
300	8		300	23		300	22	
			310	22		310	17	
			320	21	Gas	320	9	
			330	19				
			340	15				
			350	10				
			360	5				

Tests No. 7,9,10. Tx. No. 609. Data Sheet No. 13.

Normal Operation Tests Open Nozzle. Tests by A.I.[illegible]'19.

7/32" A.L.F. Nozzle, 25' A.L.F. ½" Hose. Strainer No. 2.

Stream Samples Alk. Tank Residue, 2 fl.oz. Alk.

Water 17 gals. Soda 10 Lbs. Acid 2 Lbs.

#7, 70°F.			#9, 90°F.			#10, 105°F.		
Time	Pres	Range	Time	Pres	Range	Time	Pres	Range.
10	85		10	65		10	100	
20	118	55	20	113	60	20	150	60
30	121		30	125		30	158	
40	113		40	124		40	145	
50	103		50	127		50	131	
60	94		60	120		60	120	
70	85		70	111	55	70	109	
80	77	50	80	105		80	101	55
90	71		90	95		90	93	
100	65		100	88		100	87	
110	62		110	81		110	81	50
120	60		120	77		120	77	
130	58	45	130	74		130	74	
140	56		140	71		140	71	
150	52		150	67		150	67	
160	51		160	64		160	64	Gas
170	49		170	60	Gas	170	54	
180	46		180	51		180	41	
190	44	Gas	190	39		190	29	
200	38		200	27		200	18	
210	30		210	17		210	10	
220	21		220	10		220	5	
230	12		230	5				
240	7							

Tests No. 1,2,3 Ex. No. 609. Data Sheet No. 14.

Normal Operation Tests Open Nozzle Tests by A.I.T.'19.

7/32" A.L.F. Nozzle, 25' A.L.F. ½" Hose. Strainer No. 5.

Stream Samples Alk. Tank Residue 3 fl.oz. Alk.

Water 17 gals. Soda 10 Lbs. Acid 3 Lbs.

#1, 70°F			#2, 98°F			#3, 105°F		
Time	Pres	Range	Time	Pres	Range	Time	Pres	Range
10	85		10	95		10	100	60
20	111	60	20	140	65	20	152	
30	118		30	144		30	156	
40	108		40	131	60	40	143	
50	98		50	118		50	131	
60	93		60	107		60	119	
70	88		70	98		70	108	55
80	84	55	80	91		80	100	50
90	80		90	84	55	90	93	45
100	77		100	80		100	88	
110	73		110	75	50	110	83	
120	70	50	120	71		120	78	
130	67		130	68		130	75	
140	64		140	65		140	71	
150	61		150	61		150	68	
160	59		160	59		160	65	
170	57		170	57	45	170	62	
180	55		180	55		180	60	Gas
190	52	45	190	53	Gas	190	52	
200	50		200	44		200	35	
210	48	Gas	210	34		210	25	
220	36		220	24		220	15	
230	25		230	15		230	7	
240	16		240	8				
250	7							

Tests No. 13,11,12. Mx. No. 609. Data Sheet No. 15.

Normal Operation Tests Open Nozzle. Tests by A.I.T.'19.

7/32" A.L.F. Nozzle, 25' A.L.F. ⅜" Hose. Strainer No. 2.

Stream Samples Alk. Tank Residue 3 fl.oz. Alk.

Water 17 gals. Soda 10 Lbs. Acid 2½ Lbs.

#13, 72°F.			#11, 90°F.			#12, 105°F.		
Time	Pres	Range	Time	Pres	Range	Time	Pres	Range.
10	70		10	105		10	112	
20	102	65	20	130	60	20	132	65
30	107		30	125		30	130	
40	103	60	40	111		40	121	
50	95		50	100		50	112	
60	86		60	92		60	102	60
70	77		70	84		70	92	
80	70		80	77		80	83	
90	65		90	73	55	90	77	
100	61	55	100	68		100	73	
110	57		110	64	50	110	68	55
120	54	50	120	60		120	65	
130	51		130	56		130	61	50
140	49		140	54	45	140	58	
150	47		150	51		150	56	Gas
160	45		160	49		160	51	
170	43	45	170	46	Gas	170	41	
180	41	Gas	180	38		180	30	
190	37		190	28		190	19	
200	29		200	18		200	11	
210	23		210	10		210	5	
220	16		220	4		220		
230	9							

Test No. 6,4,5. Ex. No. 609 Data Sheet No. 16.

Normal Operation Tests Closed Nozzle. Tests by A.I.T.'19.

7/32" A.L.F. Nozzle, 25' A.L.F. ½" Hose Strainer No. 5.

Stream Samples Alk. Tank Residue 3 fl.oz. Alk.

Water 17 gals. Soda 10 Lbs. Acid 3 Lbs.

#6, 70° F			#4, 90° F			#5, 105° F		
Time	Pres	Range	Time	Pres	Range	Time	Pres	Range
10	90		10	11		10	165	
20	180		20	25		20	250	
30	198		30	36		30	273	
40	205		40	47		40	286	
50	209		50	61		50	290	
60	210		60	75		60	289	
70	210		70	83		70	288	
80	211	Open	80	94		80	286	
90	143		90	106	Ex, righted	90	286	
100	118	60	100	116		100	285	Open
110	89		110	139	re-tipped	110	183	60
120	77		120	153		120	126	
130	69		130	210		130	116	
140	63		140	238		140	100	
150	60		150	247		150	90	
160	56	55	160	248		160	83	55
170	53		170	248		170	77	
180	50		180	248	Open	180	72	
190	48		190	152		190	68	
200	46		200	130	60	200	65	
210	44		210	110		210	62	50
220	42		220	97		220	59	
230	40		230	87		230	57	
240	38	45	240	81	55	240	55	
250	36		250	76		250	52	
260	35	40	260	73	50	260	50	
270	34		270	69		270	47	45
280	32		280	65		280	45	
290	31		290	62	45	290	43	
300	30		300	58		300	42	
310	29		310			310	40	40
320	28		320	55		320	38	
330	27		330	53		330	36	Gas
340	26		340	51		340	30	
350	24	Gas	350	49	20	350	20	
360	19		360	48	(nozzle	360	11	
370	11		370	48	closed)	370	5	
380	6		380	45	Open			
			390	43				
			400	41				
			410	40				
			420	38				
			430	37	Gas			
			440	33				

Note: #4. Stopple failed to fall away until machine was re-tipped

Tests No. 16,17,8. Tx, No. 609. Data Sheet No. 17.

Normal Operation Tests Tests by A.I.T.'19.

7/32" A.I.T. Nozzle, 25' A.I.T. ½" Hose. Strainer No. 2

Stream Samples Alk. Tank Residue Alk. Test #17, no strainer

Water 17 gals. Soda 10 Lbs. Acid 3 Lbs.

#16, 50°F. Open Nozzle			#17, 50°F. Closed Nozzle			#8, 70°F. Closed Nozzle		
Time	Pres	Range	Time	Pres	Range	Time	Pres	Range
10	57	55	10	110		10	90	
20	93		20	158		20	165	
30	97	60	30	171		30	220	
40	94		40	173		40	233	
50	86		50	173	Open	50	236	
60	77	55	60	105	55	60	255	
70	70	50	70	86		70	255	
80	65		80	73		80	255	Open
90	61		90	65		90	146	55
100	57		100	60		100	113	
110	54	45	110	56		110	93	50
120	52		120	53	45	120	85	
130	50		130	51		130	77	
140	49		140	49		140	73	
150	46		150	48		150	68	
160	45		150	46	40	160	64	
170	43		170	45		170	61	45
180	41	40	180	43		180	59	
190	39		190	42		190	57	
200	37	Gas	200	40		200	54	
210	33		210	39		210	51	
220	26		220	37		220	50	
230	18		230	36		230	48	40
240	11		240	35		240	45	
250	6		250	33		250	43	
			260	32		260	41	
			270	31		270	39	
			280	30		280	38	
			290	28		290	36	
			300	27	35	300	35	
			310	25	Gas	310	34	
			320	23		320	33	Gas
			330	16		330	27	
			340	10		340	21	
			350	4		350	15	
						360	9	

Note: Leak at cap

Tests No. 18,15,14. Tx. No. 609. Data Sheet No. 18.

Normal Operation Tests. Test by A.I.T.'19.

7/32" A.L.P. Nozzle, 28' A.L.P. ½" Hose Strainer No. 2.

Stream Samples Alk. Tank Residue 3 fl.oz. alk.

Water 17 gals. Soda 10 Lbs. Acid 2½ Lbs.

#18, 50° Closed #15, 50°F Open #14, 72°F Closed

Time	Pres	Range	Time	Pres	Range	Time	Pres	Range
10	81		10	64	60	10	120	
20	136		20	97	55	20	192	
30	151		30	96		30	207	
40	158		40	88		40	214	
50	161		50	75	50	50	216	
60	161		60	67		60	218	
70	161	Open	70	60		70	219	
80	94	60	80	54	45	80	220	
90	73	55	90	51		90	220	
100	62	50	100	48	40	100	220	Open
110	54		110	45		110	126	60
120	49	45	120	43		120	97	
130	46		130	41		130	81	55
140	42		140	39		140	71	
150	40	40	150	38		150	65	50
160	38		160	36		160	59	
170	37		170	34	35	170	55	
180	36		180	33		180	52	
190	34		190	32		190	50	45
200	33		200	31		200	47	
210	32		210	29		210	45	
220	31		220	28		220	44	
230	30		230	25	Gas	230	42	40
240	28	37	240	18		240	40	
250	27		250	14		250	39	
260	26	35	260	7		260	37	
270	26					270	35	
280	25					280	34	
290	24					290	32	
300	23					300	31	
310	22					310	29	
320	22					320	28	
330	21					330	27	
340	21					340	25	Gas
350	20					350	21	
360	19					360	16	
370	18	Gas				370	10	
380	14					380	5	
390	9							

Tests No. 2,1. Ex, No. 508. Data Sheet No. 19

Normal Operation Tests Open Nozzle Test by A.I.T.'19.

A.L.F. Nozzle, 25' Spero ½" Hose. Strainer No. 1.

Water 17 gals. Soda 10 Lbs. Temp. 70°F.

Stream Samples Alk. Tank Residue 48 fl.oz. Alk.

#2; 3# acid 7/32"nozzle			#1.			#1; 3½# acid 3/16"nozzle		
Time	Pres	Range	Time	Pres	Range	Time	Pres	Range
10	65		10	11		290	----	
20	102		20	10	20	300	110	
30	111	55	30	9		310	122	
40	111		40	8		320	121	
50	102		50	7½		330	115	
60	92	50	60	7		340	109	
70	85		70	6		350	105	
80	79		80	6		360	101	
90	75		90	5		370	97	
100	72		100	4½		380	93	
110	69		110	4		390	90	
120	66	45	120	3½		400	86	
130	64		130	3½		410	83	
140	60		140	3		420	81	
150	59	40	150	3		430	79	
160	57		160	3		440	76	
170	54		170	2½		450	74	
180	52		180	2½		460	72	
190	49	Gas	190	2		470	68	
200	42		200	2		480	66	
210	35		210	2		490	65	Gas
220	28		220	2		500	61	
230	20		230	2		510	56	
240	14		240	2		520	49	
250	8		250	2		530	41	
260	5		260	2		540	34	
			270	Device again		550	28	
			280	tipped.		560	22	
						570	18	
			Note: Acid bottle fell thru broken cage upon re-tipping.			580	13	
						590	8	

Tests No. 4,5,15. Ex. No. 608. Data Sheet No. 20.

Normal Operation Tests Open Nozzle. Test by A.I.T.'19.

7/32" A.L.F. Nozzle, 25' A.L.F.½" Hose Strainer No. 2.

Stream Samples Alk. Tank Residue 22 fl.oz. Alk.

Water 17 gals. Soda 10 Lbs. Acid 3 Lbs.

#4, Temp 70°F			#5, Temp 90°F			#15, Temp 105°F		
Time	Pres	Range	Time	Pres	Range	Time	Pres	Range
10	75		10	100		10	100	60
20	109	60	20	137		20	144	
30	113		30	135	60	30	148	
40	105	60	40	125		40	140	
50	96		50	113		50	128	
60	86	55	60	103		60	116	
70	81		70	95		70	106	60
80	76	55	80	87		80	97	55
90	71		90	82	55	90	91	
100	66	50	100	81		100	86	
110	63		110	74		110	81	
120	60	50	120	71		120	76	50
130	59		130	66	50	130	73	
140	56	45	140	63		140	70	
150	54		150	61		150	67	
160	51	45	160	58		160	63	Gas
170	49		170	56		170	55	
180	48	40	180	54	Gas	180	46	
190	45		190	48		190	37	
200	44	Gas	200	41		200	28	
210	39		210	33		210	20	
220	33		220	25		220	13	
230	26		230	17		230	6	
240	20		240	10				
250	16		250	5				
260	10							
270	6							

Tests No. 20,24,19. Ex No. 608 Data Sheet No. 21

Normal Operation Tests Open Nozzle. Test by A.I.T.'19.

7/32" A.L.F. Nozzle and 25' A.L.F. ½" Hose Strainer No.2.

Stream Samples Alk. Tank Residue, 22 fl.oz. Alk.

Water 17 gals Soda 10 Lbs. Acid 2½ Lbs.

#20, 70°F			#19, 105°F			#24, 90°F.		
Time	Pres	Range	Time	Pres	Range	Time	Pres	Range
10	62	65	10	93	65	10	70	65
20	105		20	135		20	119-122 max.	
30	100		30	130		30	120	
40	91		40	117		40	109	
50	80		50	105		50	98	
60	72		60	94		60	88	
70	67		70	85		70	80	
80	60		80	75		80	75	
90	55		90	72		90	70	
100	52		100	67		100	66	
110	50		110	64		110	63	
120	48		120	61		120	60	
130	46		130	59		130	57	
140	45		140	55		140	55	
150	42		150	52		150	52	
160	40		160	50	50	160	50	55
170	39		170	46	Gas	170	48	Gas
180	38		180	41		180	46	
190	36	45	190	35		190	41	
200	35	Gas	200	27		200	34	
210	32		210	20		210	25	
220	27		220	14		220	18	
230	22		230	9		230	10	
240	19		240	4		240	5	
250	15							
260	9							
270	4							

Tests No. 3,16,14. Ex. No. 608 Data Sheet No. 22

Normal Operation Tests Closed Nozzle Test by A.L.T.'19.

7/32" A.L.F. Nozzle, 25' A.L.F. Hose ¾". Strainer No.1 Test 3

Stream Samples Alk. Tank Residue Alk. " No.2 Test 16,14.

Water 17 gals Soda 10 Lbs. Acid 3 Lbs.

#3, 69°F			#16, 90°F			#14, 105°F		
Time	Pres	Range	Time	Pres	Range	Time	Pres	Range
10	35		10	145		10	155	
20	83		20	213		20	233	
30	113		30	244		30	260	
40	140		40	257		40	267	
50	153		50	261		50	270	
60	161		60	262		60	273	
70	167		70	262		70	273	
80	172		80	262	Open	80	273	
90	174		90	151	55	90	272	Open
100	175		100	127		100	162	50
110	176		110	109		110	180	
120	177		120	99	55	120	113	
130	177		130	91		130	105	55
140	176	Open	140	84		140	96	
150	122	55	150	80	50	150	91	50
160	101	65	160	76		160	87	
170	85		170	73		170	83	45
180	78	60	180	70		180	77	
190	73	60	190	66	45	190	74	45
200	69		200	63		200	71	
210	66		210	60	45	210	68	
220	63	60	220	57		220	64	
230	60		230	54		230	61	45
240	59	55	240	51		240	58	
250	56		250	49		250	55	
260	54	55	260	47	45	260	53	45
270	52		270	45	Gas	270	50	Gas
280	50	50	280	41		280	44	
290	48		290	34		290	36	
300	45	45	300	27		300	28	
310	44		310	21		310	20	
320	42	40	320	15		320	13	
330	40		330	9		330	7	
340	39	40	340	5				
350	37							
360	35	35						
370	34	Gas						
380	28							
390	24							
400	19							
410	15							
420	11							
430	7							

Tests No. 22,21. Ex. No. 608. Data Sheet No. 23.

Normal Operation Tests Closed Nozzle Test by A.I.T.'19.

7/32" A.L.F.Nozzle, 25' A.L.F. ½" Hose. Strainer No. 2.

Stream Samples Alk. Tank Residue 22fl. oz. Alk. in #21.

Water 17 gals Soda 10 Lbs. Acid 2½ lbs.

22. 90°F

Time	Pres	Range
10	75	
20	165	
30	195	
40	205	
50	210	
60	210	

Note: Test No. 22 Coupling blew off gauge hose. Peak pressure had been reached.

#21. 105°F

Time	Pres	Range
10	90	
20	180	
30	215	
40	225	
50	233	
60	235	
70	236	
80	236	
90	237	Open
100	153	55
110	120	
120	100	
130	90	
140	80	
150	74	
160	69	
170	65	
180	61	
190	59	
200	55	
210	52	
220	48	
230	47	
240	44	
250	42	
260	40	50
270	39	Gas
280	35	
290	29	
300	24	
310	16	
320	12	
330	5	

Tests No. 30,31. Ex. No. 608. Data Sheet No. 24.

Normal Operation Tests. Test by A.I.T.'19.

7/32" A.L.F. Nozzle, 25' Spero ½" Hose Strainer No. 2.

Stream Samples Alk. Tank Residue 22 fl.oz. Alk.

Water 17 gals Soda 10 Lbs. Acid 3 Lbs. #30, 46°F; #31, 45°F.

#30, Closed.

Time	Pres	Range
10	85	
20	139	
30	153	
40	158	
50	158	
60	158	Open
70	97	60
80	77	55
90	69	50
100	63	
110	59	45
120	56	
130	54	
140	52	
150	51	
160	49	
170	47	
180	45	
190	43	
200	41	40
210	39	
220	38	
230	36	
240	35	
250	33	
260	32	
270	30	
280	29	
290	28	
300	27	Gas
310	23	
320	19	
330	14	
340	9	

#31, Open.

Time	Pres	Range
10	90	55
20	101	
30	93	
40	84	
50	75	50
60	68	
70	62	
80	58	
90	54	45
100	52	
110	50	
120	48	
130	46	40
140	45	
150	43	
160	41	
170	40	
180	38	
190	37	
200	35	
210	34	Gas
220	31	
230	25	
240	20	
250	15	
260	10	
270	5	

Tests No. 29,8,28. Ex. No. 508. Data Sheet No. 26.

Normal Operation Tests Open Nozzle. Test by A.I.T.'19.

7/32" A.L.F.Nozzle, 25' Spero ½"Hose. Strainer No. 2.

Stream Samples Alk. Tank Residue 22 fl.oz. Alk.

Soda 10 Lbs. Acid 3Lbs. Solution Temp. 70°F.

#29, 16½ gal sol			#8, 17½ gal sol			#28, 18 gal sol.		
Time	Pres	Range	Time	Pres	Range	Time	Pres	Range
10	78		10	80		10	97	60
20	114		20	54		20	119	
30	115	60	30	78	60	30	115	55
40	106		40	90		40	106	
50	96	55	50	92		50	94	50
60	88		60	91		60	86	
70	91		70	88		70	79	50
80	76	50	80	85		80	75	
90	71		90	80		90	69	50
100	67	50	100	75		100	64	
110	63		110	71	55	110	61	
120	61	45	120	68		120	58	
130	59		130	64		130	55	
140	56		140	62		140	52	45
150	53	45	150	59		150	51	
160	51		160	56	45	160	49	
170	49		170	53		170	47	
180	47	Gas	180	51		180	45	
190	44		190	49		190	44	
200	37		200	48	Gas	200	42	Gas
210	30		210	41		210	37	
220	23		220	33		220	31	
230	16		230	24		230	25	
240	11		240	17		240	19	
250	6		250	12		250	13	
			260	6		260	7	

Tests Nos. 26,11,12. Ex. No. 608 Data Sheet No. 26.

Normal Operation Tests Closed Nozzle. Test by A.I.T.'19.

7/32" A.L.F. Nozzle, 25' A.L.F.½"Hose Strainer No. 2.

Stream Samples Alk. Tank Residue. #26,11 alk. #12, acid.

Soda 10 Lbs. Acid 3 Lbs. Solution Temp. #26, 69°F. #11,12, 70°F.

#26,17 gals. sol			#11,18 gals sol			#12,19 gals sol.		
Time	Pres	Range	Time	Pres	Range	Time	Pres	Range
10	105		10	155		10	140	
20	170		20	190		20	210	
30	189		30	205		30	233	
40	195		40	209		40	235	
50	198		50	212		50	236	
60	200		60	212		60	235	
70	200		70	211		70	236	
80	200	Open	80	210	Open	80	236	Open
90	125	50	90	127	60	90	117	50
100	99		100	97		100	98	
110	87		110	82	55	110	82	55
120	78	50	120	75		120	76	
130	73		130	71	50	130	73	50
140	69	50	140	67		140	69	
150	66		150	64	50	150	67	
160	62	45	160	61		160	65	
170	59		170	59	50	170	62	50
180	57	45	180	56		180	59	
190	54	45	190	53	45	190	57	45
200	52		200	51		200	54	
210	50	45	210	48	45	210	52	
220	48		220	45		220	50	
230	46		230	44	40	230	48	45
240	44		240	43		240	45	
250	42		250	41	40	250	43	40
260	41		260	39		260	42	
270	39	40	270	37	40	270	40	
280	37		280	36		280	38	
290	36	Gas	290	34		290	36	40
300	29		300	33		300	35	
310	22		310	31	Gas	310	33	
320	18		320	27		320	32	Gas
330	13		330	23		330	28	
340	8		340	18		340	24	
350	4		350	12		350	19	
360	0		360	6		360	14	
						370	9	
						380	5	

Tests No. 9,23. Ex. No. 608. Data Sheet No. 27.

Operation Tests (Full acid bottle) Test by A.I.T.'19.

7/32" A.L.F. Nozzle, 25' A.L.F. Hose. Strainer No.2.

Stream Samples Alk. Tank Residue 22 fl.oz. Alk.

Water 17 gals. Soda 10 Lbs. Acid 4 Lbs. 7 Oz. Sol. Temp. 70°F.

#9, Open Nozzle

Time	Pres	Range
10	94	
20	140	
30	146	
40	142	
50	130	
60	121	
70	113	
80	107	
90	101	
100	96	
110	92	
120	88	
130	85	
140	79	
150	76	
160	72	
170	68	Gas
180	60	
190	50	
200	38	
210	27	
220	17	
230	10	
240	6	

#23, Closed Nozzle

Time	Pres	Range
10	100	
20	219	
30	245	
40	260	
50	261	
60	262	
70	263	
80	265	
90	265	
100	265	
110	265	Open
120	170	55
130	142	
140	130	
150	122	
160	118	
170	110	
180	106	
190	101	
200	95	
210	90	
220	85	
230	80	
240	76	
250	74	
260	70	
270	67	45
280	65	Gas
290	61	
300	56	
310	47	
320	37	
330	26	
340	13	
350	9	
360	4	

Tests No. 6,7. Wx. No. 608. Data Sheet No. 28

Normal Operation Tests Open Nozzle Test by A.I.T.'19.

7/32"A.L.F. Nozzle, 25' A.L.F. ½" Hose Strainer No. 2.

Stream Samples Alk. Tank Residue 22 fl. oz. Acid

Solution 17 gals. Soda 10 Lbs. Acid 3 Lbs. Temp. 70°F.
" 17½ "

#6.--17 gals. sol.			#7.--17½ gals. sol.		
Time	Pres	Range	Time	Pres	Range
10	65		10	35	
20	110		20	75	
30	110		30	95	
40	101		40	97	
50	92		50	94	
60	85		60	89	
70	79		70	84	
80	74		80	80	
90	70		90	75	
100	65		100	70	
110	62		110	66	
120	60		120	63	
130	56		130	61	
140	54		140	56	
150	52		150	55	
160	50		160	52	
170	48		170	51	
180	46		180	49	
190	45		190	48	
200	42		200	45	Gas
210	36	Gas	210	38	
220	29		220	30	
230	22		230	22	
240	16		240	16	
250	10		250	11	
260	5		260	5	

Tests Nos. 18,27,25. Ex. 608. Data Sheet No. 29.

Normal Operation Tests, Closed Nozzle. Test by A.I.T.'19.

7/32" A.L.F. Nozzle, 25' A.L.F. ½"Hose. Strainer No. 2.

Stream Samples Alk. Tank residue 22 fl. oz. #18 acid. #27,25 alk

Water 17 gals. Acid 3 Lbs. Temp. #18, 72°F. #27, 25, 70°F.

#18, Soda 6#			#27, Soda 8#			#25, Soda 12#		
Time	Pres	Range	Time	Pres	Range	Time	Pres	Range
10	95		10	92		10	120	
20	140		20	150		20	195	
30	152		30	165		30	221	
40	158		40	171		40	227	
50	161		50	175		50	231	
60	161	Open	60	177		60	231	Open
70	116	50	70	178		70	140	65
80	97		80	178		80	110	
90	87	50	90	178	Open	90	95	60
100	80		100	117	60	100	85	
110	77		110	94		110	80	
120	75		120	85		120	76	55
130	72		130	80		130	71	
140	69		140	76	50	140	67	50
150	66		150	73		150	63	
160	63	50	160	70	50	160	60	50
170	60		170	67		170	58	
180	57	45	180	64	45	180	55	45
190	54		190	61		190	52	
200	51		200	58		200	50	
210	49		210	55		210	48	
220	47	40	220	52	45	220	46	
230	45		230	50		230	44	45
240	43		240	48		240	42	
250	41		250	47		250	41	Gas
260	39		260	45		260	36	
270	37	Gas	270	43		270	31	
280	32		280	41	40	280	25	
290	25		290	39		290	19	
300	20		300	37	Gas	300	13	
310	14		310	32		310	8	
320	8		320	26				
			330	20				
			340	15				
			350	9				
			360	4				

Tests No. 10,17,13. Ex. No. 608. Data Sheet No. 30.

Normal Operation Tests. (Misc.) Tests by A.I.T.'19.

7/32" A.L.F. Nozzle, 25' A.L.F. ½" Hose. Strainer No.2.

Stream Samples Alk. Tank Residue Alk.

#10,, 70°F
Open Nozzle.
17 gals. sol.
Soda 10#. Acid 3#.

Time	Pres	Range
10	82	
20	120	
30	117	
40	107	
50	96	
60	87	
70	81	
80	75	
90	72	
100	69	
110	64	
120	62	
130	60	
140	57	
150	54	
160	51	
170	49	
180	47	
190	45	Gas
200	38	
210	29	
220	21	
230	14	
240	9	

#17,-70°F
Closed Nozzle.
17 gals sol.
Soda 13½#. Acid 3#.

Time	Pres	Range
10	137	
20	220	
30	280	

Note: Nozzle blew off hose. Pressure at gas 37 Lbs.

#13,-71°F.
Closed Nozzle.
Water 17 gals.
Soda 7½#. Acid 2½#

Time	Pres	Range
10	20	
20	60	
30	86	
40	107	
50	120	
60	128	
70	132	
80	136	
90	139	
100	139	
110	140	
120	141	
130	141	Open
140	92	55
150	78	
160	71	50
170	65	
180	61	
190	58	
200	55	
210	53	45
220	50	
230	48	
240	46	
250	44	
260	42	
270	41	
280	39	
290	37	
300	36	40
310	34	
320	33	
330	32	
340	30	
350	29	40
360	27	Gas
370	23	
380	19	
390	15	
400	11	
410	7	

Note: Test #13. Bottle cage spread, stopple held slightly by edge of cage.

Ex. No. 473.

American La France 20-Gallon Chemical Fire Engine.

CURVE SHEET INDEX

Sheet No.	Test Nos.	Variables.
1	1,2.	Acid Charge
2	1,6.	" "
3	4,5,6,7,8.	Nozzle Orifice Size
4	9,7,15.	Acid Feed
5	10,11,12.	Temperature
6	3,5.	Acid Charge
7	13,15,14.	Temperature

Ex. No. 585.

O. J. Childs 20-Gallon Chemical Fire Engine.

8	2,3,4.	Temperature
9	6,7,8.	"
10	13,14,15.	"
11	19,17.	Acid Charge
12	16,17.	Temperature
13	5,6,10.	Acid Feed
14	1,9.	Nozzle Orifice Size
15	2,9.	Type of Nozzle
16	4,18.	" " Strainer
17	9,12.	Strainer & Tip Angle

Ex. No. 609.

Ajax 20-Gallon Chemical Fire Extinguisher

18	1,2,3.	Temperature
19	16,7,9,10.	"
20	11,12,13,15.	"
21	15,16.	Acid Charge
22	17,18.	" "
23	6,4,5,17.	Temperature
24	18,14.	"
25	4.	
26	8.	

Ex. No. 608.

Spero-20-Gallon Fire Extinguisher.

CURVE SHEET INDEX.

Sheet No.	Test Nos.	Variables.
27	1.	
28	2.	
29	31,4,5,15.	Temperature
30	20,24,19.	"
31	30,3,16,14.	"
32	22,21.	"
33	20,4,9.	Acid Charge
34	24,5.	" "
35	19,15.	" "
36	3,22.	" "
37	16,23.	" "
38	14,21.	" "
39	5,7.	Solution Quantity
40	10,8,4.	" "
41	29,10,8,28.	" "
42	26,3,11,12.	" "
43	18,27,26,25,17.	Soda Charge
44	13.	

Tests By A.I.T. '19.

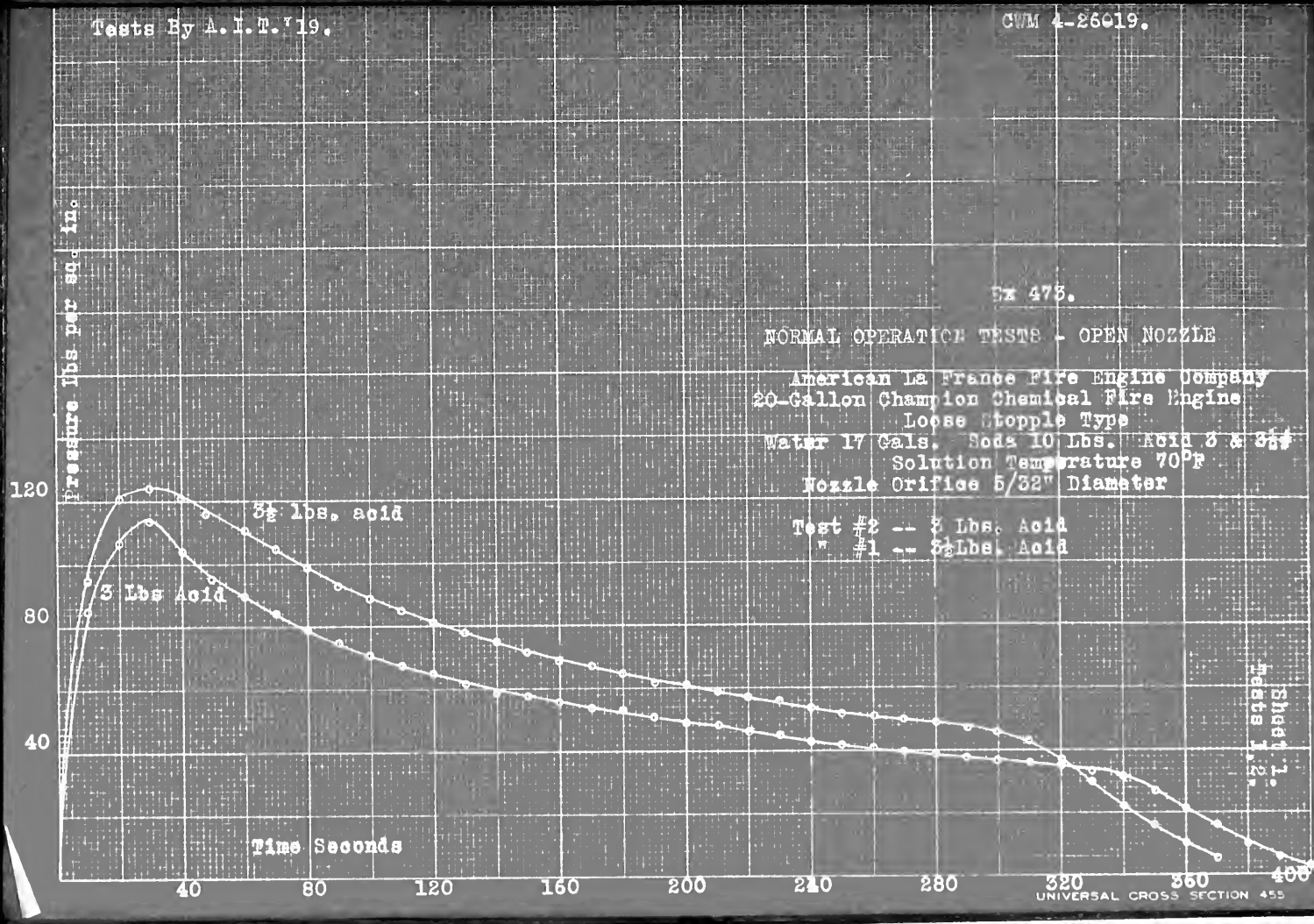
CWM 4-26019.

Ex 473.

NORMAL OPERATION TESTS - OPEN NOZZLE

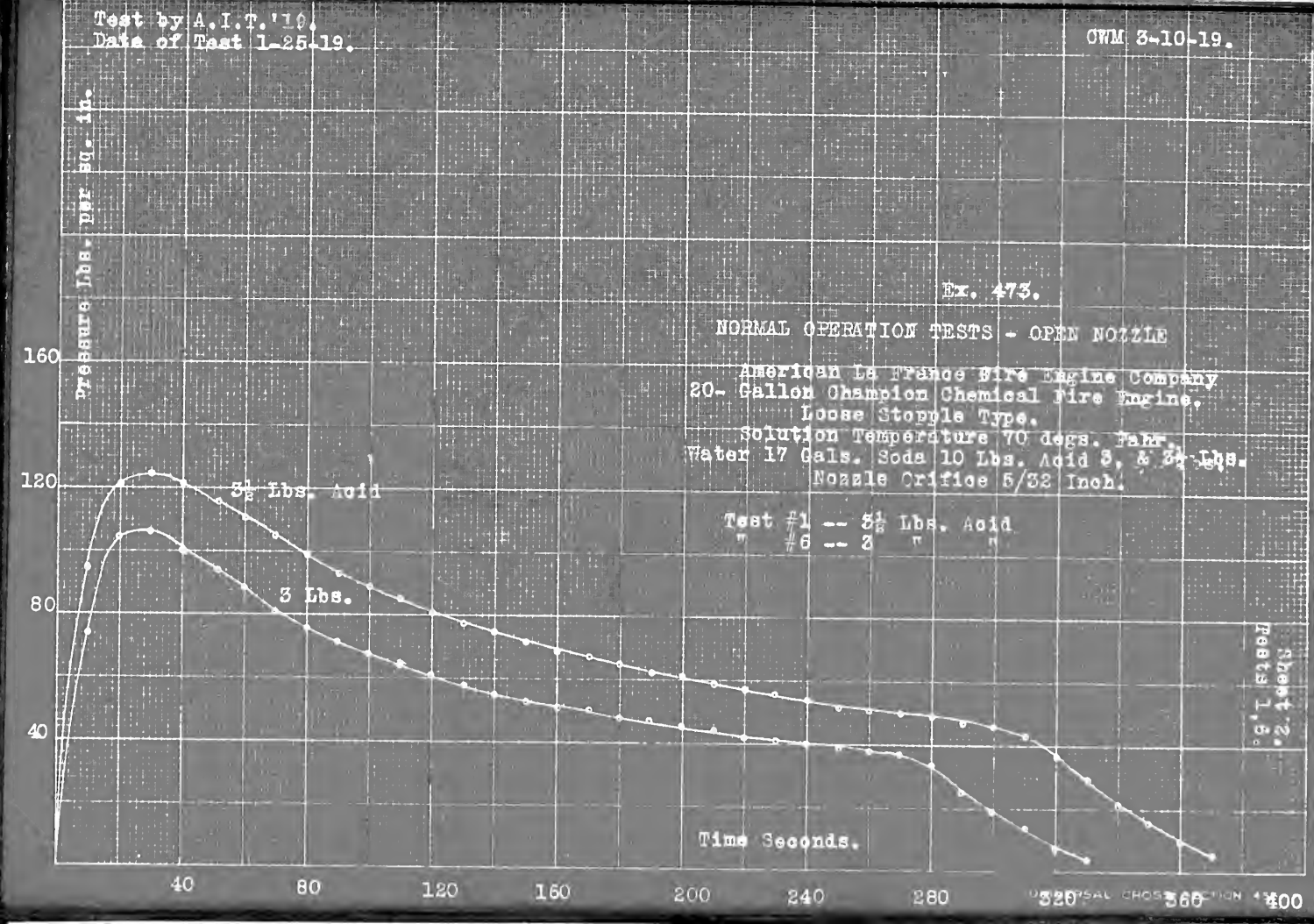
American La France Fire Engine Company
20-Gallon Champion Chemical Fire Engine
Loose Stopple Type
Water 17 Gals. Soda 10 Lbs. Acid 3 & 3½#
Solution Temperature 70°F
Nozzle Orifice 5/32" Diameter

Test #2 -- 3 Lbs. Acid
" #1 -- 3½ Lbs. Acid



Sheet 1 of 2 Tests

UNIVERSAL CROSS SECTION 455

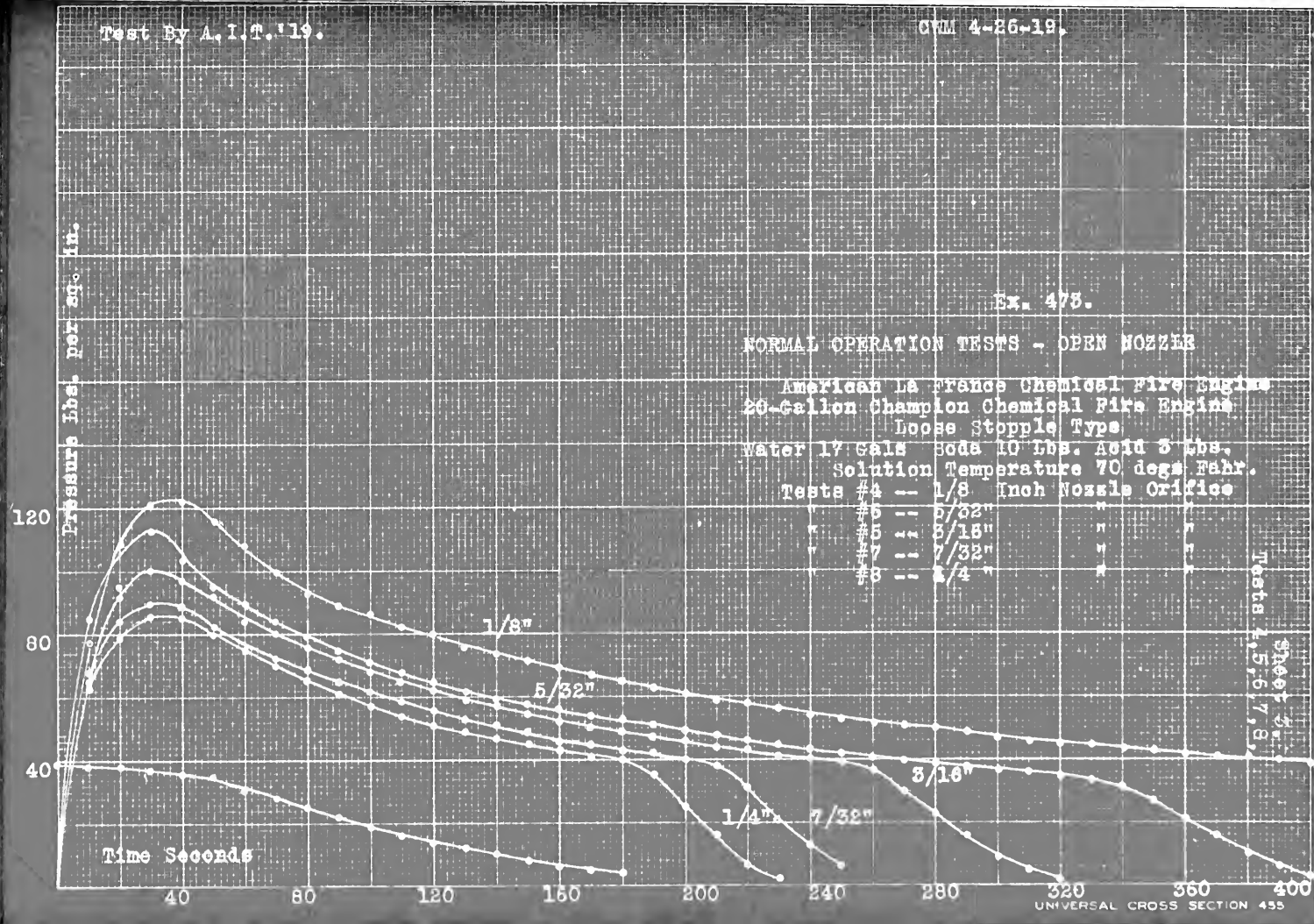

Test by A.I.T.'19.
Date of Test 1-25-19.
CWM 3-10-19.
Pressure Lbs. per sq. in.
Ex. 473.
NORMAL OPERATION TESTS - OPEN NOZZLE
American La France Fire Engine Company
20- Gallon Champion Chemical Fire Engine.
Loose Stopple Type.
Solution Temperature 70 degs. Fahr.
Water 17 Gals. Soda 10 Lbs. Acid 3, & 3½ Lbs.
Nozzle Orifice 5/32 Inch.
Test #1 -- 3½ Lbs. Acid
" #6 -- 3 " "
3½ Lbs. Acid
3 Lbs.
Time Seconds.
160
120
80
40
40
80
120
160
200
240
280
320
360
400
Sheet 2.
Tests 1, 6.

Test By A.I.T.'19. CFM 4-26-19.

Ex. 473.

NORMAL OPERATION TESTS - OPEN NOZZLE

American La France Chemical Fire Engine
20-Gallon Champion Chemical Fire Engine
Loose Stopple Type
Water 17 Gals Soda 10 Lbs. Acid 3 Lbs.
Solution Temperature 70 degs Fahr.
Tests #4 -- 1/8 Inch Nozzle Orifice
" #5 -- 5/32" " "
" #6 -- 3/16" " "
" #7 -- 7/32" " "
#8 -- 1/4" " "



Test By A.I.E.'19.

CWL 4-28-19.

Ex. 473.

NORMAL OPERATION TESTS - OPEN NOZZLE

American La France Fire Engine Company
20-Gallon Champion Chemical Fire Engine
Loose Stopple Type
Water 17 Gals. Soda 10 Lbs. Acid 8 Lbs.
Solution Temperature 70 Degs Fahr.
Nozzle Orifice 7/32 Inch.
Note: #7, Normal acid feed
#9, No stopple
#10, No guide

Pressure Lbs. per sq. in.

120

80

40

#9

#7

#10

Time Seconds

40 80 120 160 200 240 280

Tests 7, 9, 10.

Sheet 4.

UNIVERSAL CROSS SECTION 455

Test By A.I.T. '19.

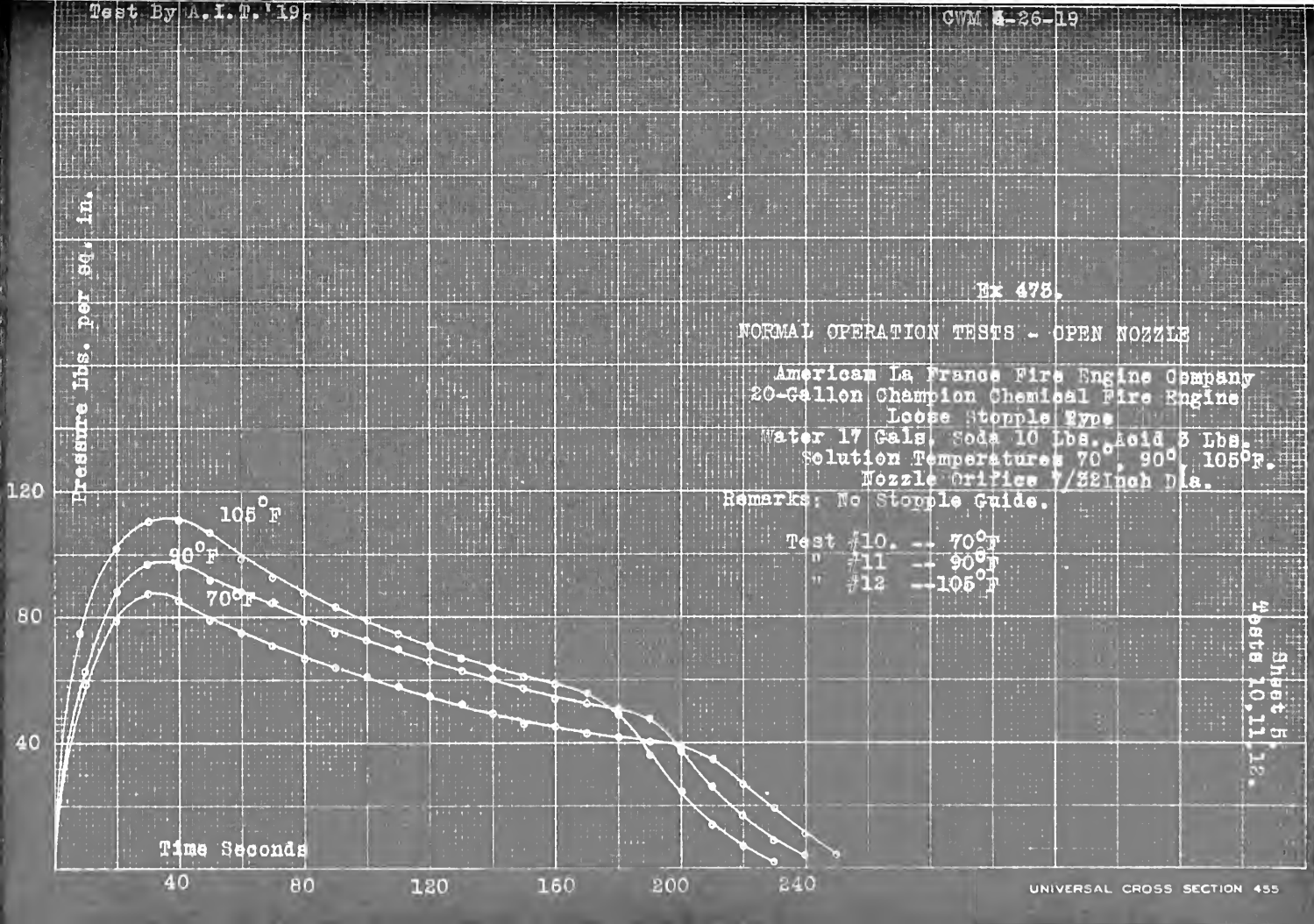
CWM 4-26-19

Ex 478.

NORMAL OPERATION TESTS - OPEN NOZZLE

American La France Fire Engine Company
20-Gallon Champion Chemical Fire Engine
Loose Stopple Type
Water 17 Gals. Soda 10 Lbs. Acid 8 Lbs.
Solution Temperatures 70°, 90°, 105°F.
Nozzle Orifice 7/32 Inch Dia.
Remarks: No Stopple Guide.

Test #10. -- 70°F
" #11 -- 90°F
" #12 --105°F



Sheet 5.
Tests 10,11,12.

UNIVERSAL CROSS SECTION 455

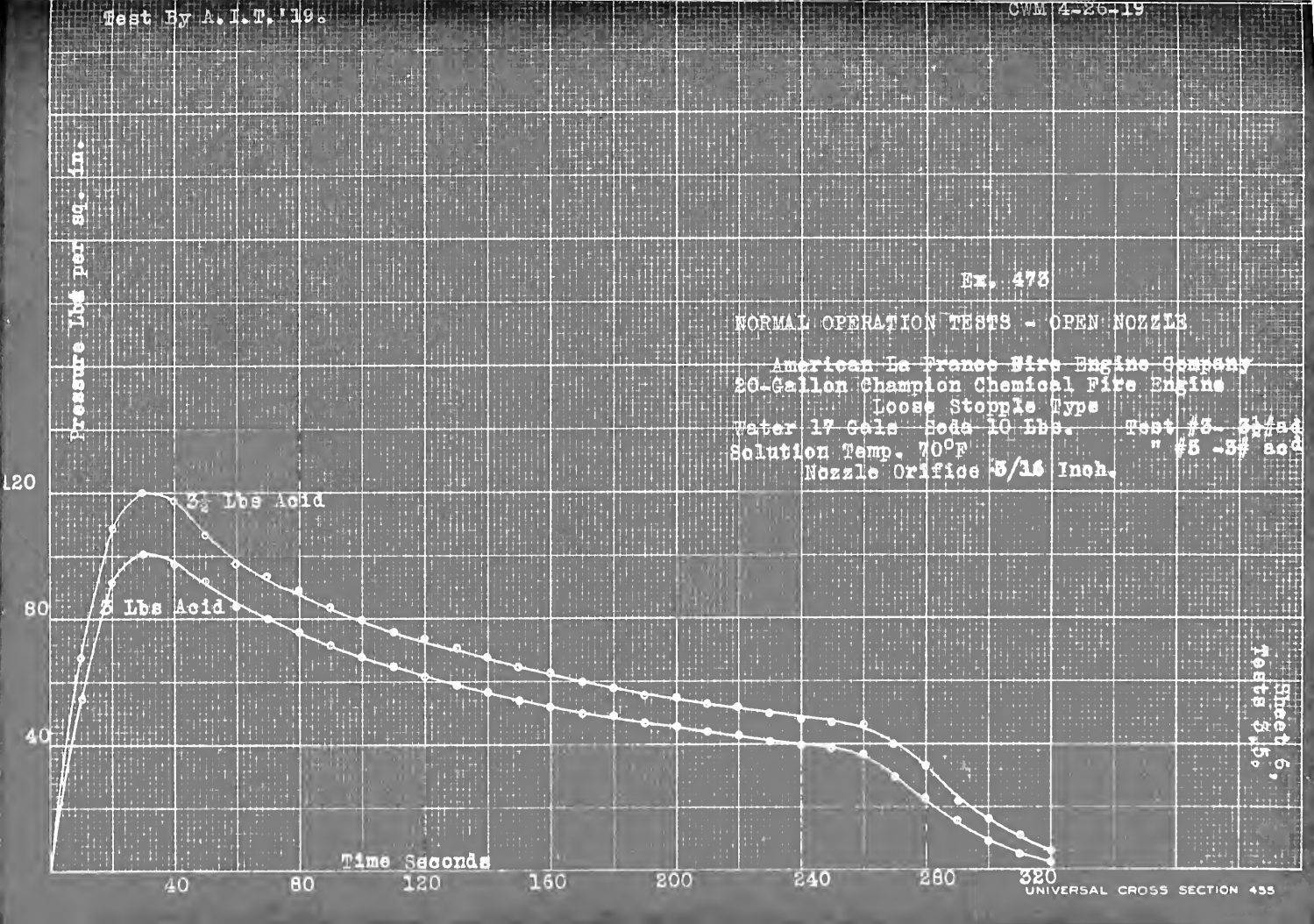
Test By A.I.T. '19.

CWM 4-26-19

Ex. 473

NORMAL OPERATION TESTS - OPEN NOZZLE

American La France Fire Engine Company
20-Gallon Champion Chemical Fire Engine
Loose Stopple Type
Water 17 Gals Soda 10 Lbs. Test #3- 3½#acid
Solution Temp. 70°F " #5 -5# acid
Nozzle Orifice 5/16 Inch.



Test By A.I.T.'19.

CWM 4-28-19.

Ex. 473.

NORMAL OPERATION TESTS - CLOSED NOZZLE

American La France Fire Engine Company
20-Gallon Champion Chemical Fire Engine
Loose Stopple Type.
Water 17 Gals. Soda 17 Lbs. Acid 3 Lbs.
Nozzle Orifice 7/32 Inch.

Test #14. -- 70 Degs Fahr.
" #13, -- 90 " "
" #15, -- 105 " "

Sheet 7.
Tests 13, 14, 15.

Pressure Lbs. per sq. in.

240

180

120

60

Time Seconds

60 120 180 240 300 360

UNIVERSAL CROSS SECTION 455

Test by A.I.T.'19
Date of Test 2-17-19.

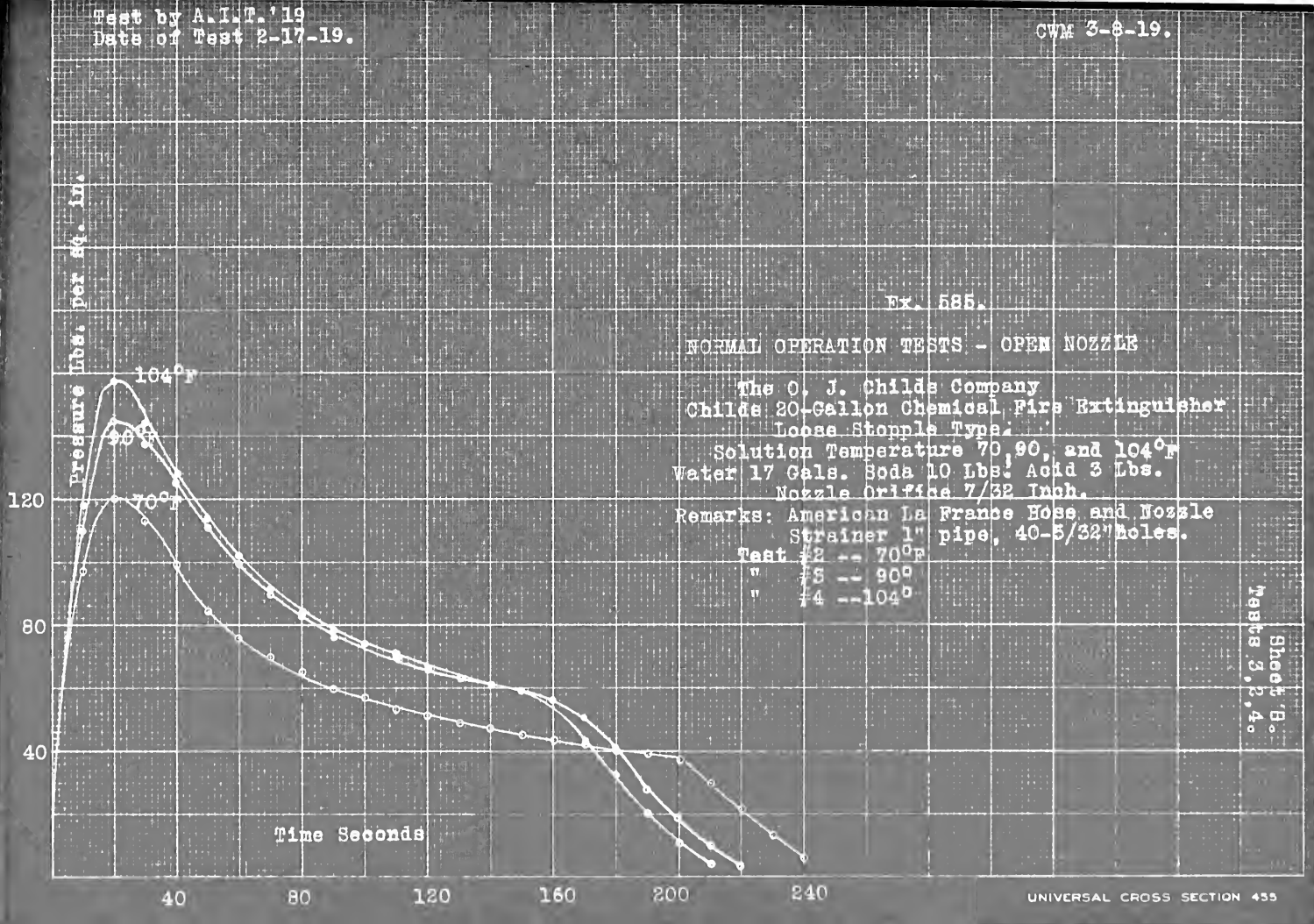
CWM 3-8-19.

Ex. 685.

NORMAL OPERATION TESTS - OPEN NOZZLE

The O. J. Childs Company
Childs 20-Gallon Chemical Fire Extinguisher
Loose Stopple Type.
Solution Temperature 70, 90, and 104°F
Water 17 Gals. Soda 10 Lbs. Acid 3 Lbs.
Nozzle Orifice 7/32 Inch.
Remarks: American La France Hose and Nozzle
Strainer 1" pipe, 40-5/32" holes.
Test #2 -- 70°F
" #3 -- 90°
" #4 --104°

Sheet 'B'.
Tests 3, 2, 4.



UNIVERSAL CROSS SECTION 455

Test by A.I.F.'19.
Date of Test 2-17-19.

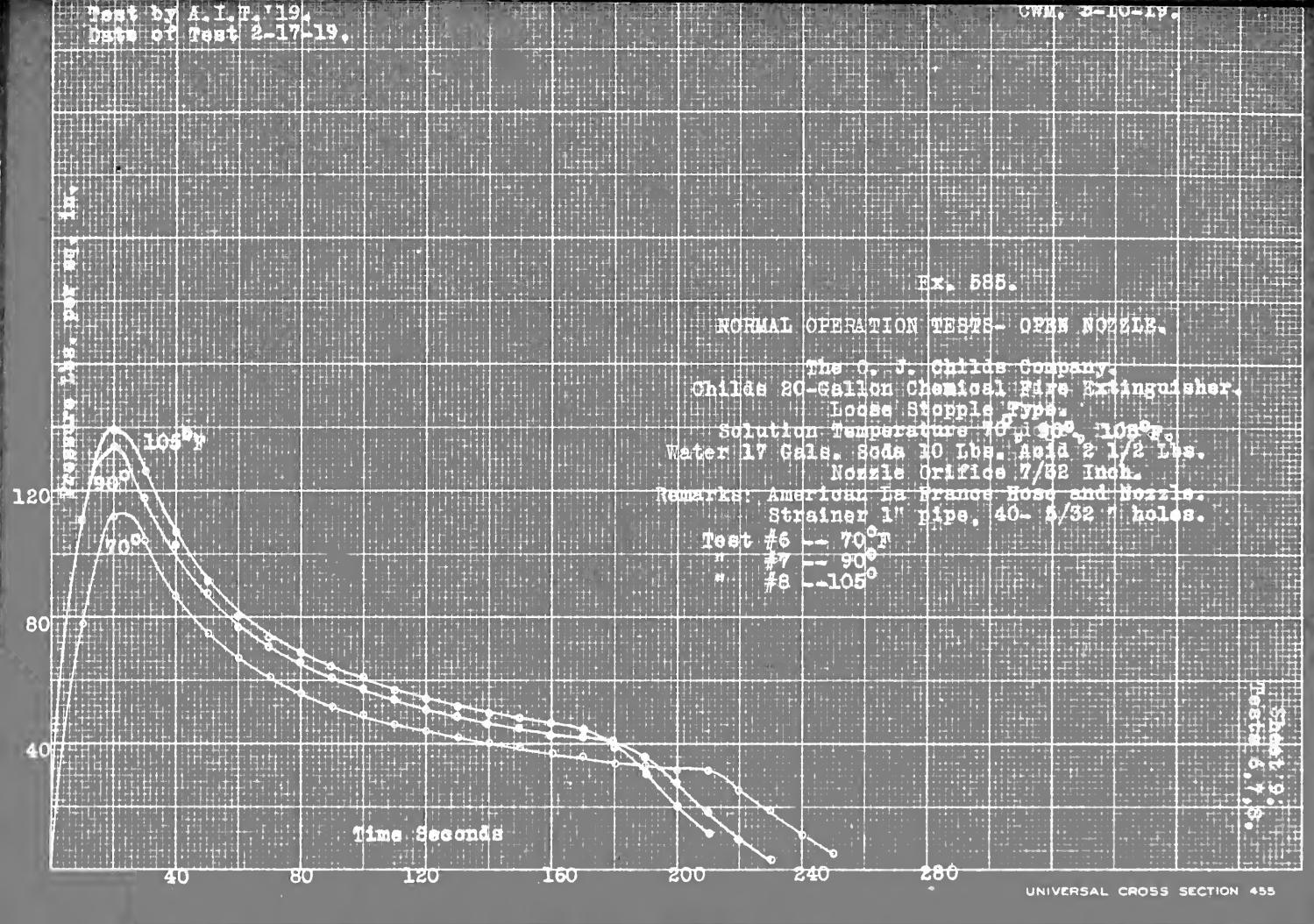
CWH. 3-10-19.

Ex. 585.

NORMAL OPERATION TESTS- OPEN NOZZLE.

The C. J. Childs Company.
Childs 20-Gallon Chemical Fire Extinguisher.
Loose Stopple Type.
Solution Temperature 70°, 90°, 105°F.
Water 17 Gals. Soda 10 Lbs. Acid 2 1/2 Lbs.
Nozzle Orifice 7/32 Inch.
Remarks: American La France Hose and Nozzle.
Strainer 1" pipe, 40- 5/32 " holes.

Test #6 -- 70°F
" #7 -- 90°
" #8 --105°



UNIVERSAL CROSS SECTION 455

Test by A.I.T. '19.
Date of Test 2 - 19 -19.

CWM 3-15-19.

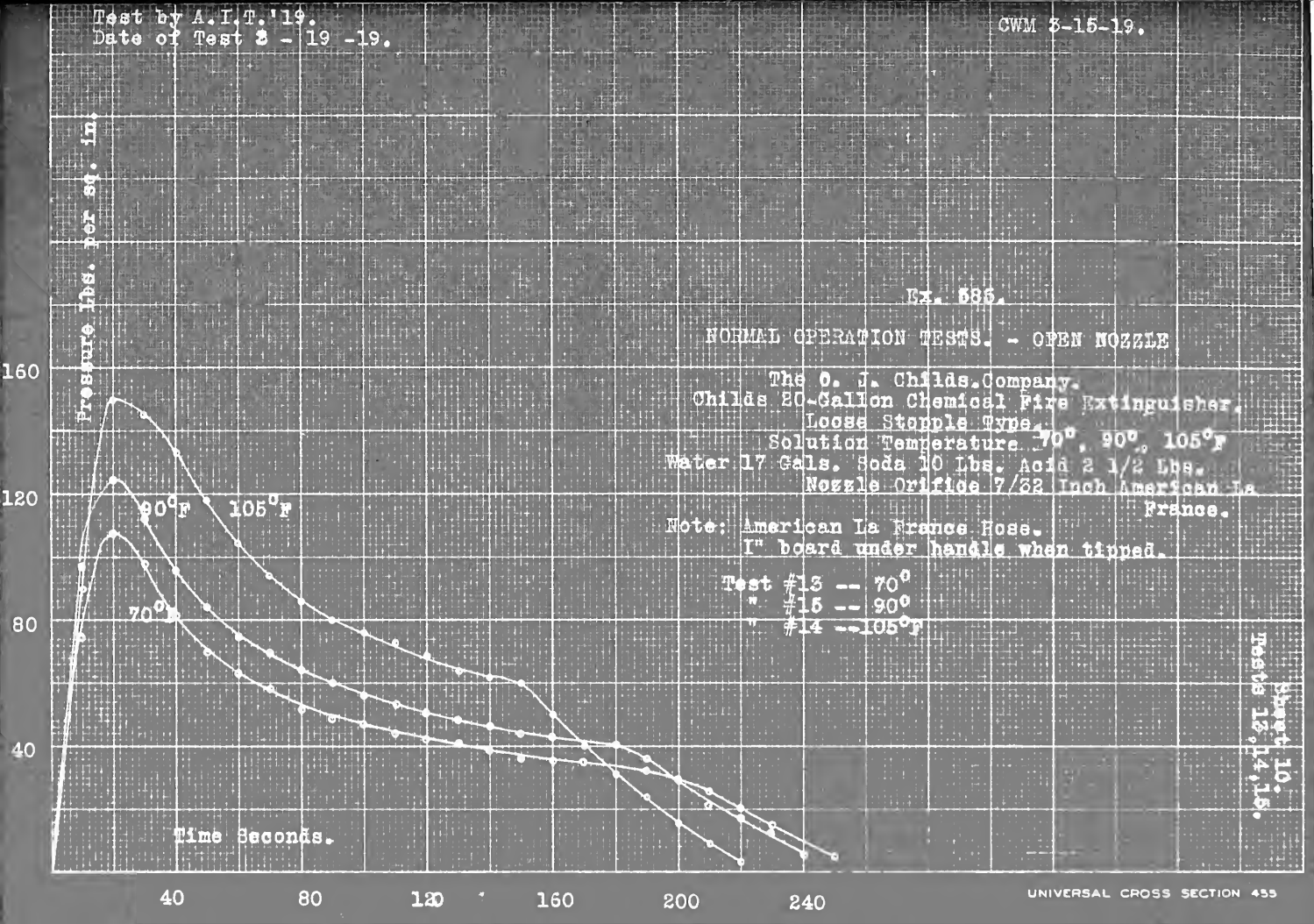
Ex. 685.

NORMAL OPERATION TESTS. - OPEN NOZZLE

The O. J. Childs Company.
Childs 20-Gallon Chemical Fire Extinguisher.
Loose Stopple Type.
Solution Temperature 70°, 90°, 105°F
Water 17 Gals. Soda 10 Lbs. Acid 2 1/2 Lbs.
Nozzle Orifice 7/32 Inch American La France.

Note: American La France Hose.
1" board under handle when tipped.

Test #13 -- 70°
" #15 -- 90°
" #14 --105°F

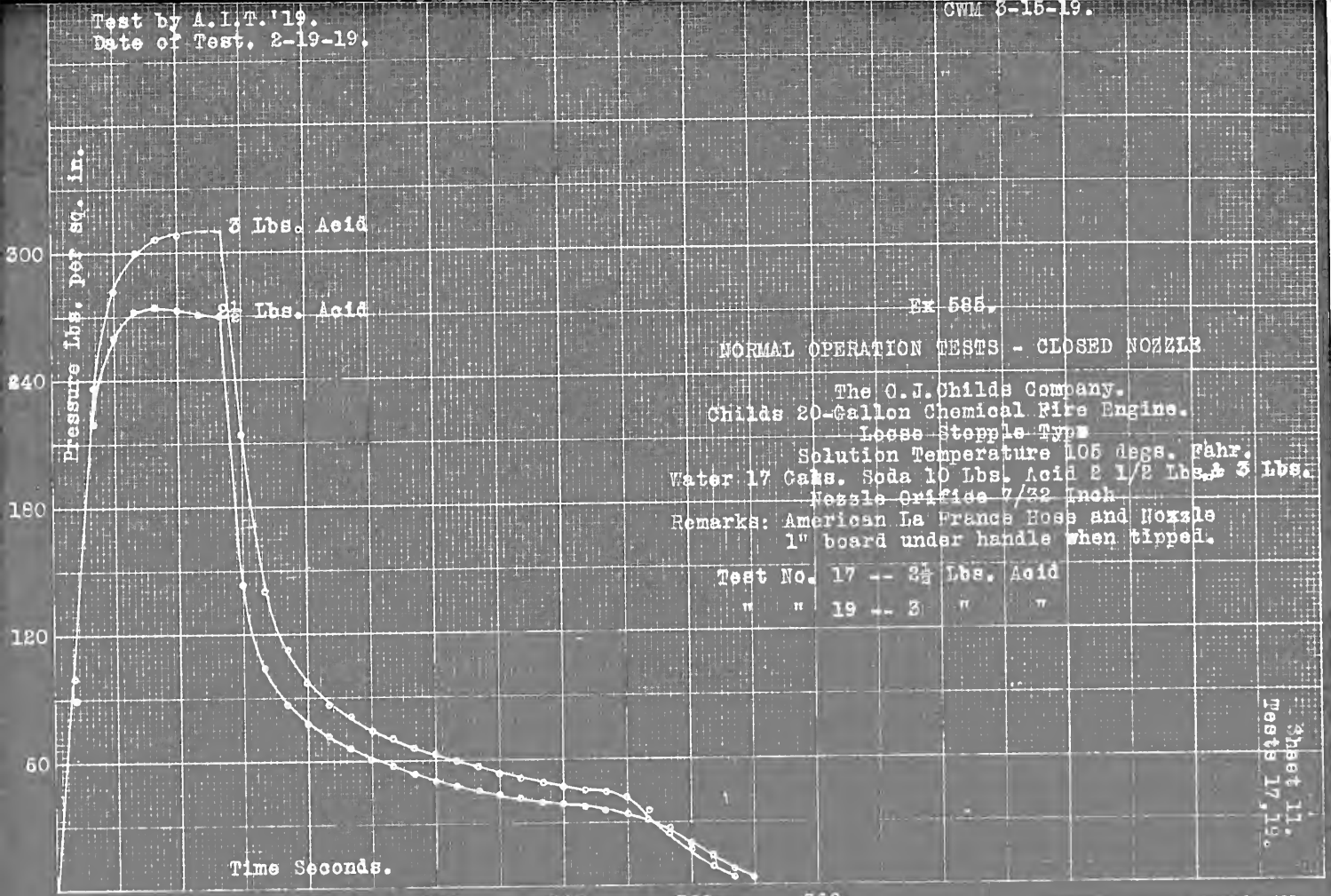


Sheet 10.
Tests 13, 14, 15.

UNIVERSAL CROSS SECTION 455

Test by A.I.T.'19.
Date of Test. 2-19-19.

CWM 3-15-19.



Ex 585.

NORMAL OPERATION TESTS - CLOSED NOZZLE

The O.J.Childs Company.
Childs 20-Gallon Chemical Fire Engine.
Loose Stopple Type.
Solution Temperature 105 degs. Fahr.
Water 17 Gals. Soda 10 Lbs. Acid 2 1/2 Lbs. & 3 Lbs.
Nozzle Orifice 7/32 Inch.
Remarks: American La France Hose and Nozzle
1" board under handle when tipped.

Test No. 17 -- 2½ Lbs. Acid
" " 19 -- 3 " "

Sheet 11.
Tests 17,19.

UNIVERSAL CROSS SECTION 455

Test by A.I.T.'19.
Data of Test 2-19-19.

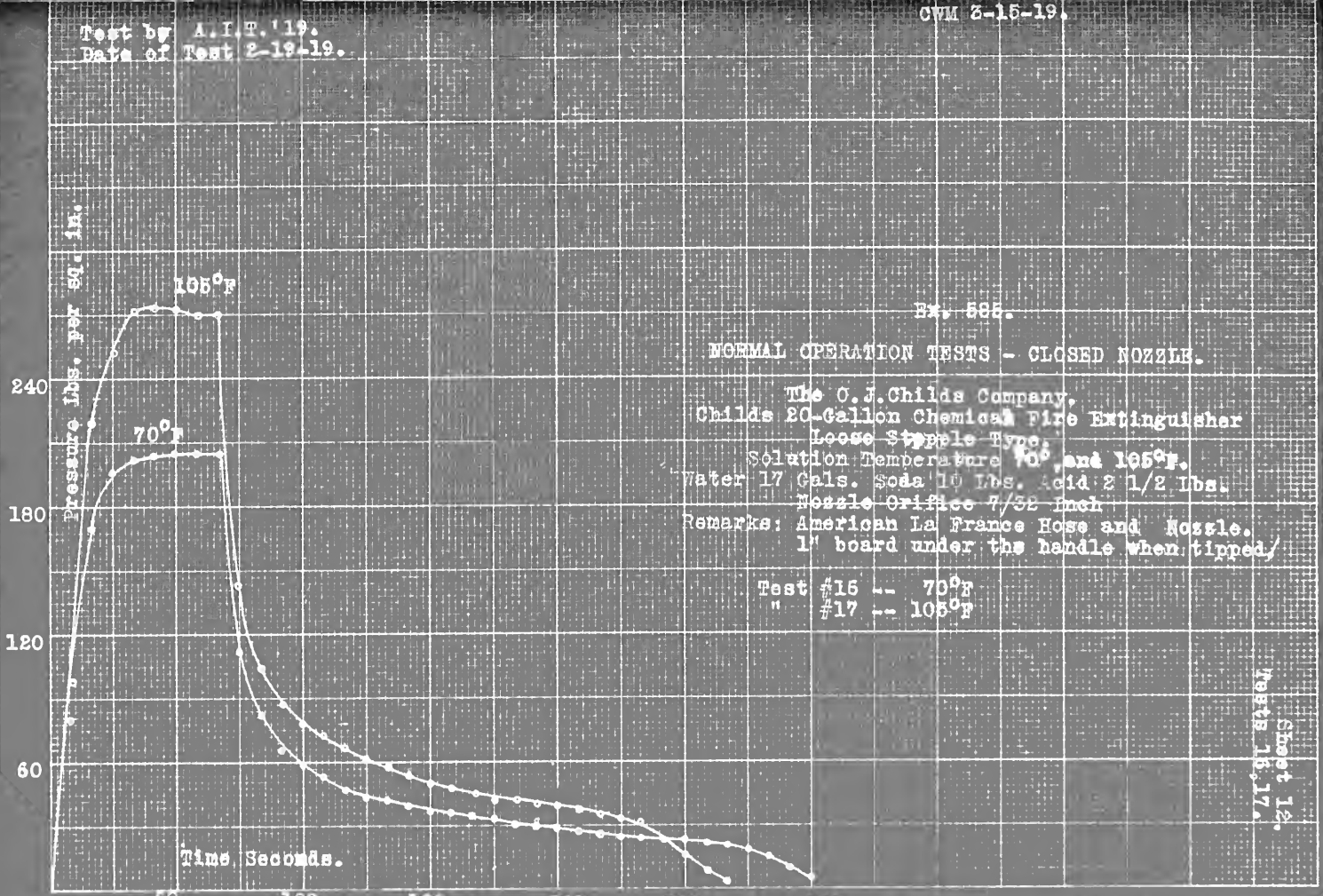
CWM 2-15-19.

Ex. 588.

NORMAL OPERATION TESTS - CLOSED NOZZLE.

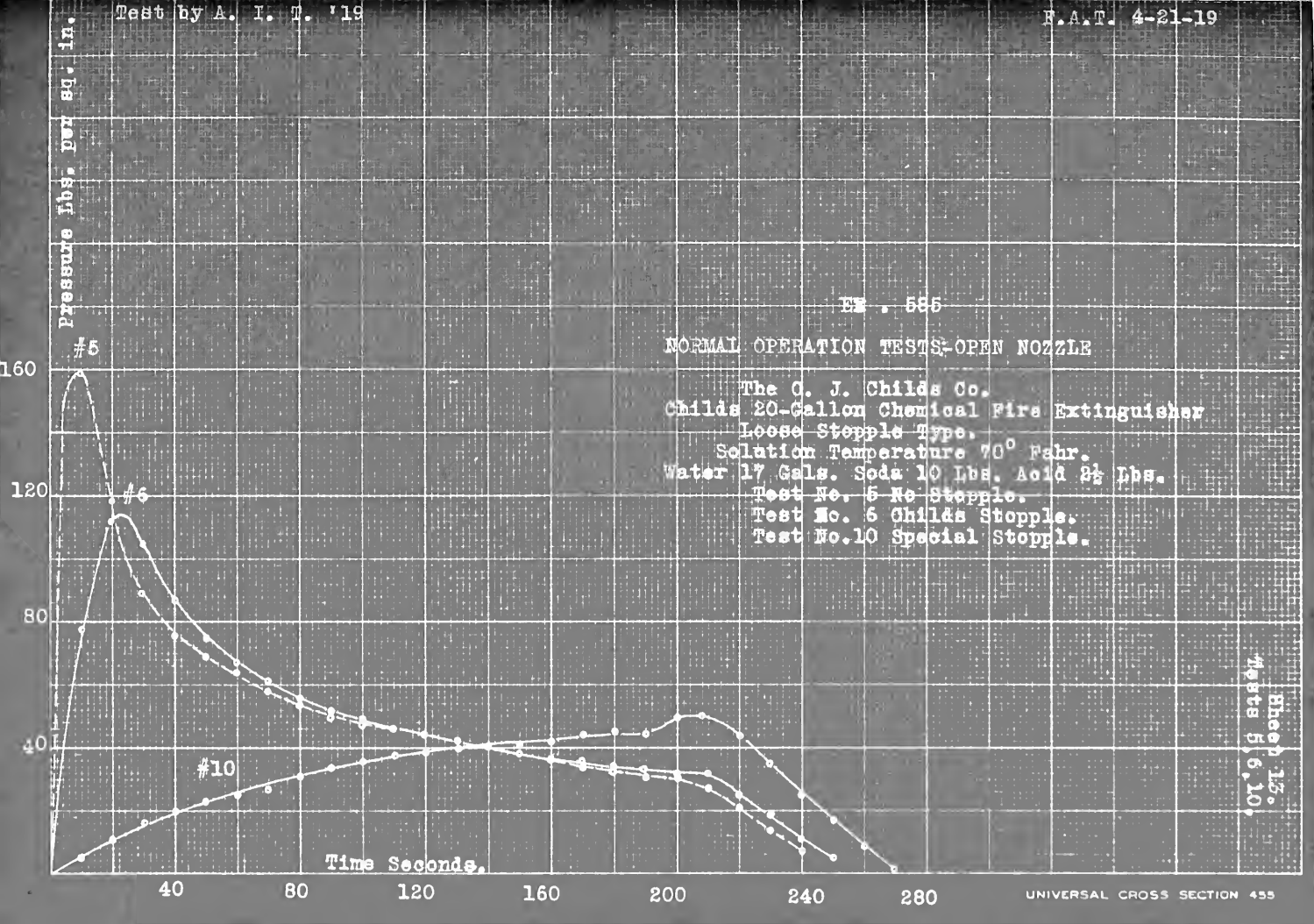
The C.J.Childs Company,
Childs 20-Gallon Chemical Fire Extinguisher
Loose Stopple Type.
Solution Temperature 70° and 105°F.
Water 17 Gals. Soda 10 Lbs. Acid 2 1/2 Lbs.
Nozzle Orifice 7/32 Inch
Remarks: American La France Hose and Nozzle.
1" board under the handle when tipped.

Test #16 -- 70°F
" #17 -- 105°F



Sheet 12.
Tests 16,17.

UNIVERSAL CROSS SECTION 455


Test by A. I. T. '19
F.A.T. 4-21-19
Pressure lbs. per sq. in.
#5
#6
#10
160
120
80
40
Time Seconds.
40
80
120
160
200
240
280
Ex . 586
NORMAL OPERATION TESTS-OPEN NOZZLE
The C. J. Childs Co.
Childs 20-Gallon Chemical Fire Extinguisher
Loose Stopple Type.
Solution Temperature 70° Fahr.
Water 17 Gals. Soda 10 Lbs. Acid 8½ Lbs.
Test No. 5 No Stopple.
Test No. 6 Childs Stopple.
Test No.10 Special Stopple.
Sheet 12.
#5, #6, #10.
UNIVERSAL CROSS SECTION 455

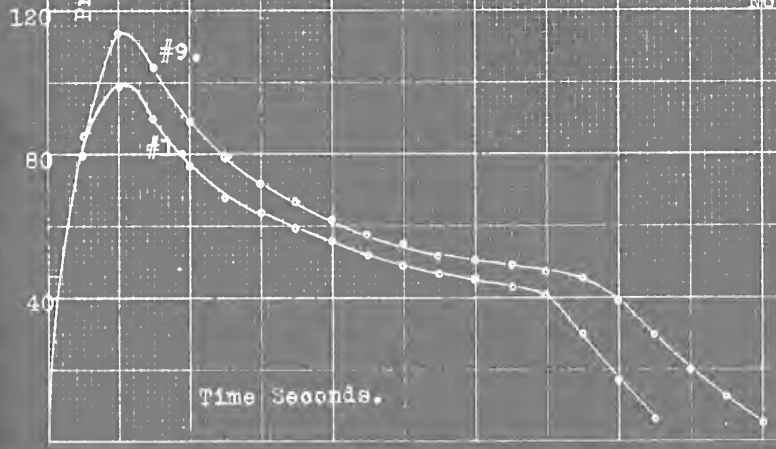
CWM 3-15-19.

Test by A.I.T.'19
Date of Test 2-19-19.

Ex. 685.

NORMAL OPERATION TESTS - OPEN NOZZLE

The O.J. Childs Company.
Childs 20-Gallon Chemical fire Extinguisher.
Loose Stopple Type.
Solution Temperature 70 degs. Fahr,
Water 17 Gals. Soda 10 Lbs. Acid 3 Lbs.
Note: #1 - Nozzle Orifice 1/4 Inch O.J.C.
#9 - " " 7/32 Inch O.J.C.



Sheet 14.
Tests 1,9.

UNIVERSAL CROSS SECTION 455

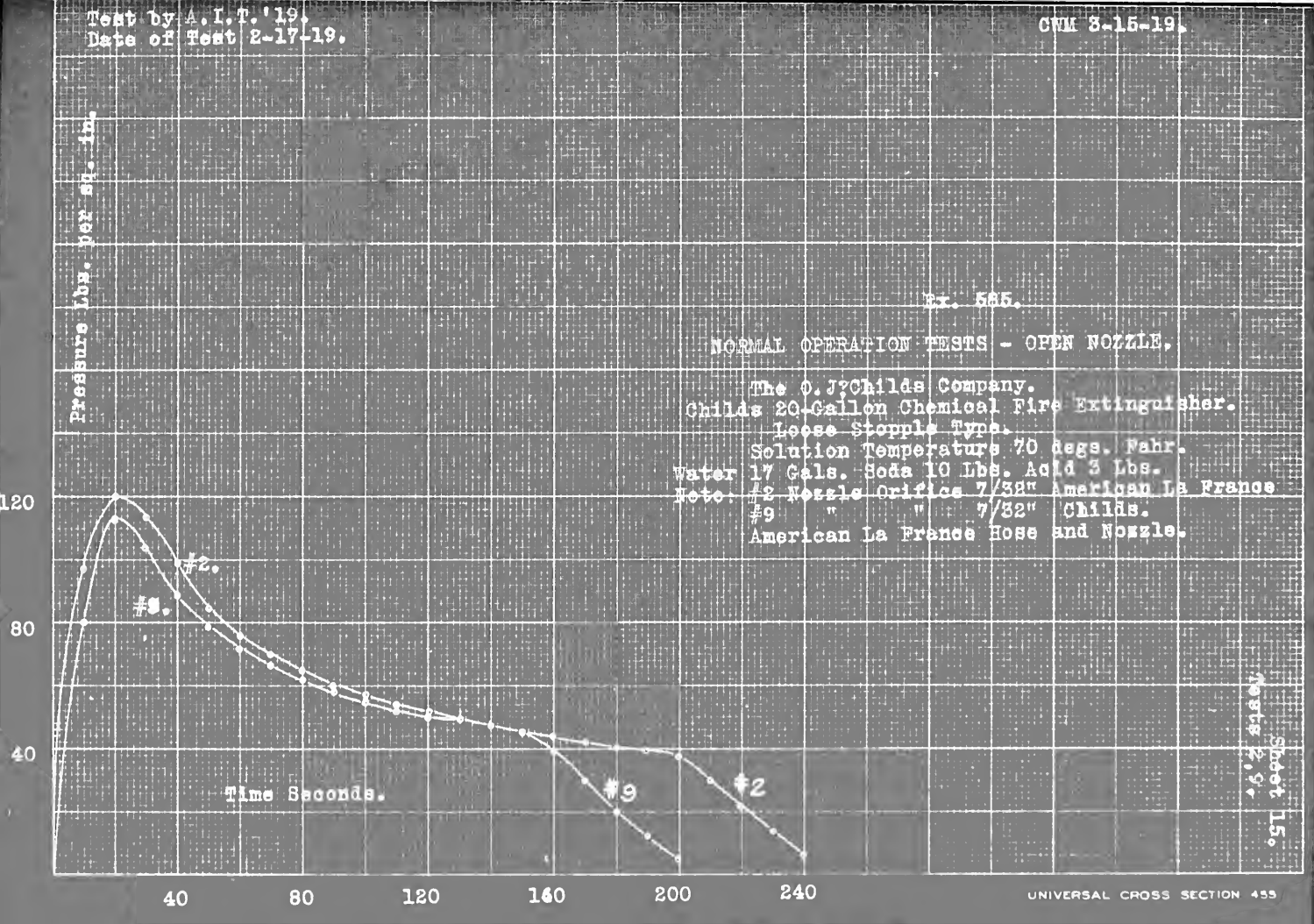
Test by A.I.T.'19.
Date of Test 2-17-19.

CWM 8-15-19.

Ex. 585.

NORMAL OPERATION TESTS - OPEN NOZZLE.

The C. J. Childs Company.
Childs 20-Gallon Chemical Fire Extinguisher.
Loose Stopple Type.
Solution Temperature 70 degs. Fahr.
Water 17 Gals. Soda 10 Lbs. Acid 3 Lbs.
Note: #2 Nozzle Orifice 7/32" American La France
#9 " " 7/32" Childs.
American La France Hose and Nozzle.



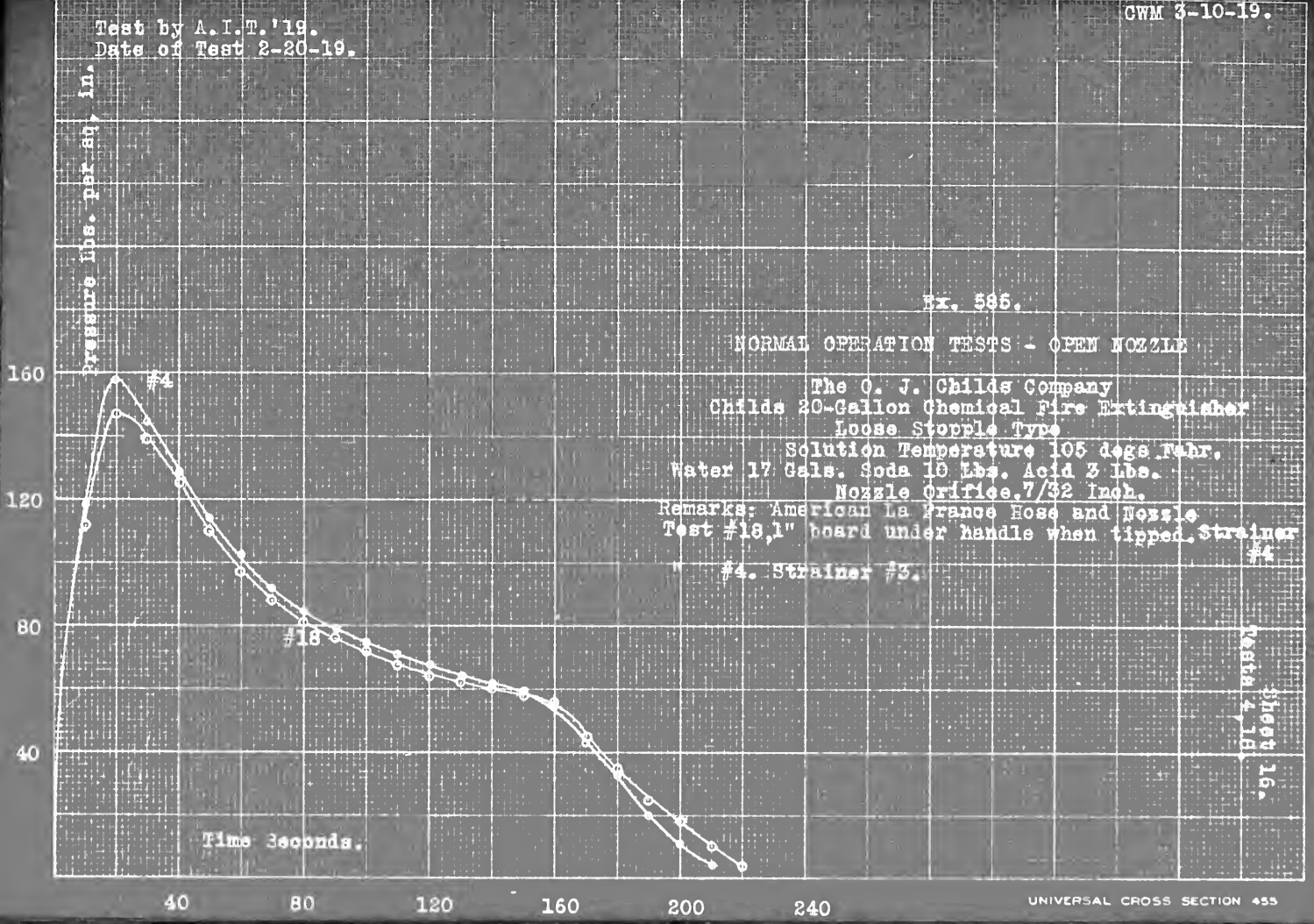
Test by A.I.T.'19.
Date of Test 2-20-19.

CWM 3-10-19.

Ex. 585.

NORMAL OPERATION TESTS - OPEN NOZZLE

The O. J. Childs Company
Childs 20-Gallon Chemical Fire Extinguisher
Loose Stopple Type
Solution Temperature 105 degs. Fahr.
Water 17 Gals. Soda 10 Lbs. Acid 3 Lbs.
Nozzle Orifice.7/32 Inch.
Remarks: American La France Hose and Nozzle
Test #18,1" board under handle when tipped. Strainer #4
" #4. Strainer #3.



Sheet 16.
Tests 1-18

UNIVERSAL CROSS SECTION 455

Test by A.I.T.'19.
Date of Test 2-18019.

CWM 3-10-19.

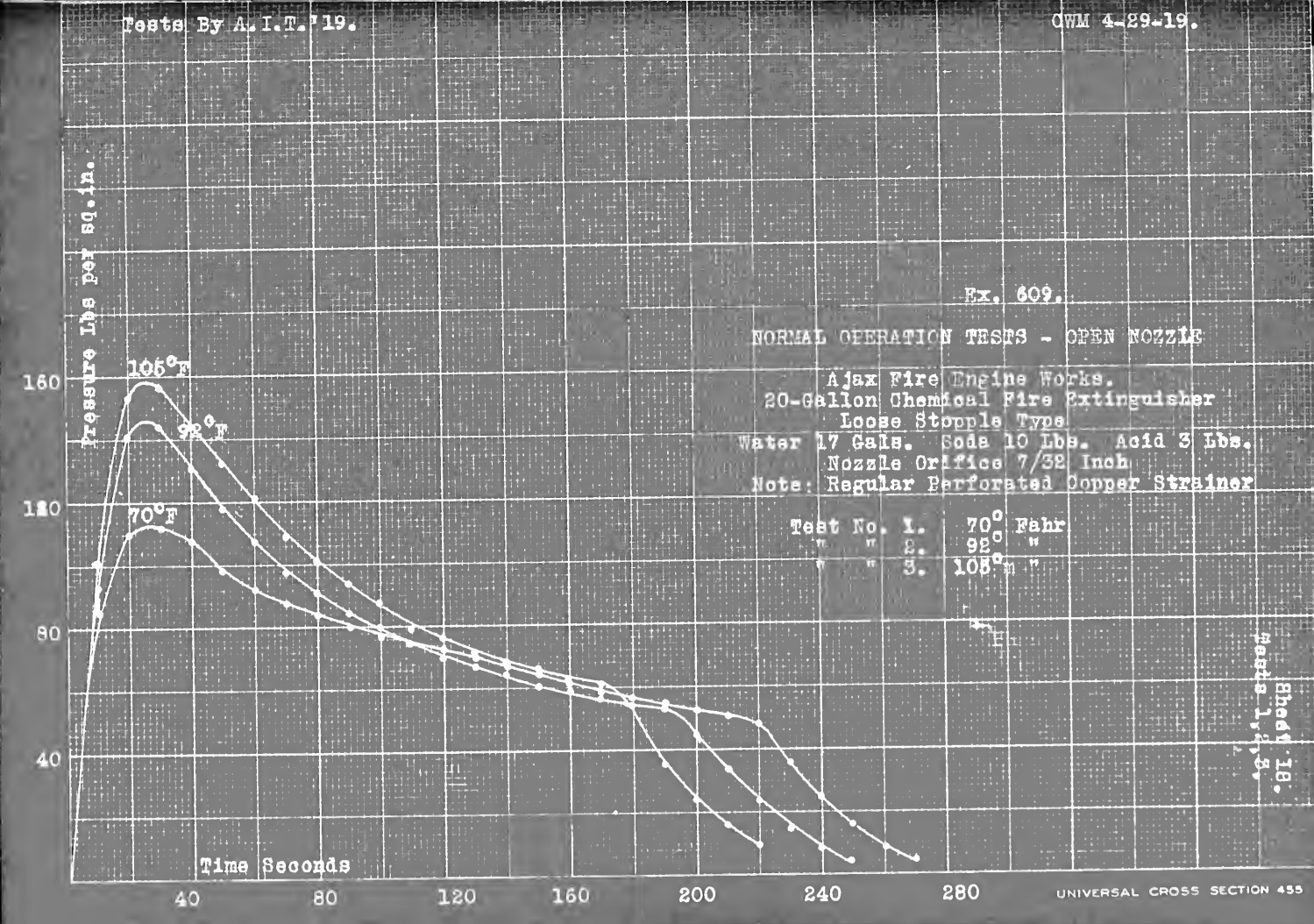
Ex 585.

NORMAL OPERATION TESTS # OPEN NOZZLE

The O.J. Childs Company.
Childs 20 Gallon Chemical Fire Extinguisher.
Loose stopple type
Solution Temperature 70 degs Fahr.
Water 17 Gals. Soda 10 Lbs. Acid 3 Lbs.
Nozzle Orifice 7/32 Inch.
Remarks: 1" board under handle when tipped.
Test #9- Strainer 1" pipe, 40 - 5/32 " holes
Childs nozzle.

Test #12- 2" Block under handle when tipped
Strainer No.4.

Tests By A.I.T. '19. CWM 4-29-19.



Ex. 609.

NORMAL OPERATION TESTS - OPEN NOZZLE

Ajax Fire Engine Works.
20-Gallon Chemical Fire Extinguisher
Loose Stopple Type
Water 17 Gals. Soda 10 Lbs. Acid 3 Lbs.
Nozzle Orifice 7/32 Inch
Note: Regular Perforated Copper Strainer

Test No. 1. 70° Fahr
" " 2. 92° "
" " 3. 105° "

Sheet 18.
Tests 1, 2, 3.

Tests By A.I.T.'19.

CWM 4-26-19

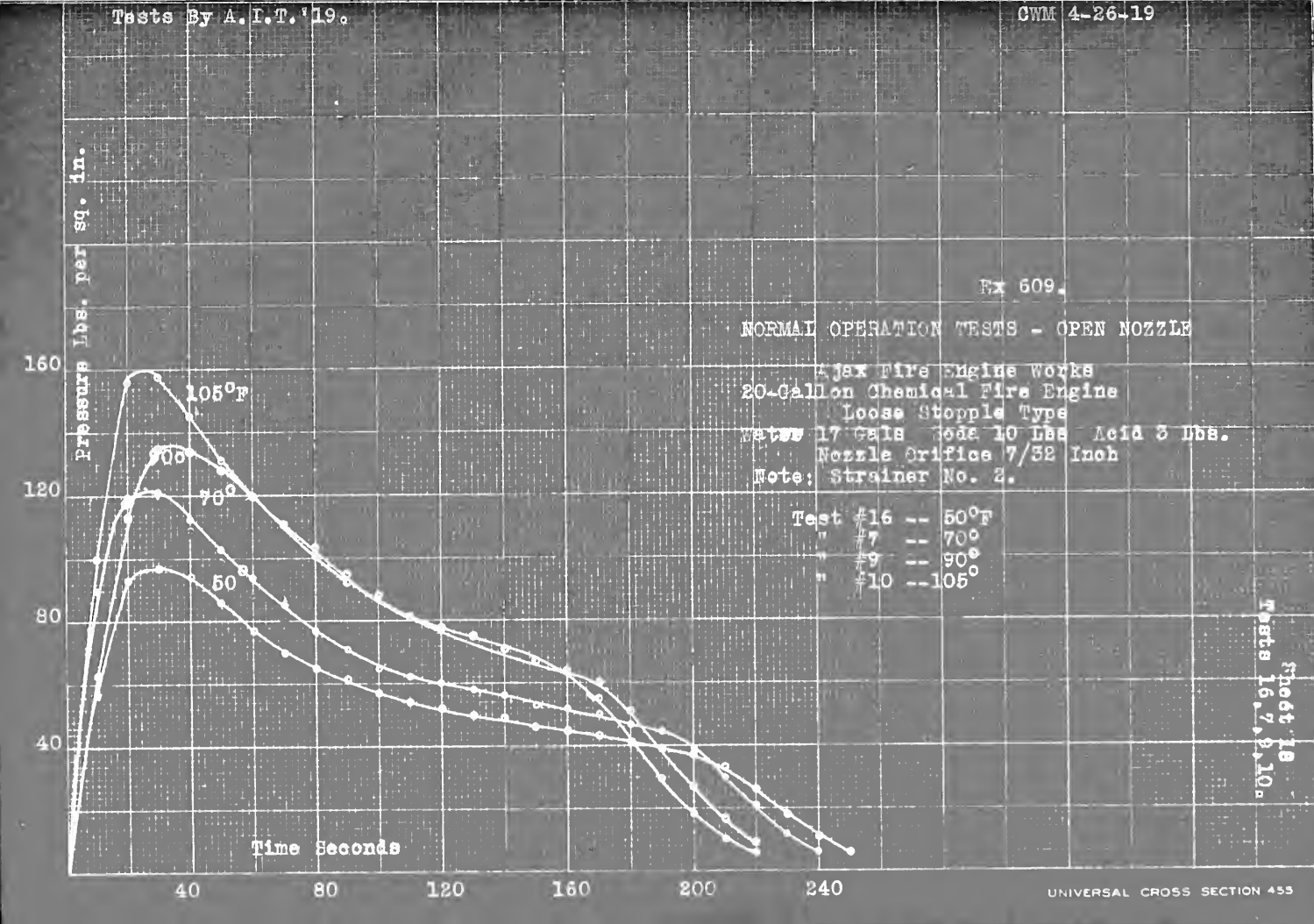
Ex 609.

NORMAL OPERATION TESTS - OPEN NOZZLE

Ajax Fire Engine Works
20-Gallon Chemical Fire Engine
Loose Stopple Type
Water 17 Gals Soda 10 Lbs Acid 3 Lbs.
Nozzle Orifice 7/32 Inch
Note: Strainer No. 2.

Test #16 -- 50°F
" #7 -- 70°
" #9 -- 90°
" #10 --105°

Sheet 10
Tests 16, 7, 9, 10.



UNIVERSAL CROSS SECTION 455

Test By A.I.T.'19.

Date of Test ---

C.W.M. 2-24-19.

Ex. 609.

NORMAL OPERATION TESTS - OPEN NOZZLE.

Ajax Fire Engine Works.
20- Gallon Chemical Fire Extinguisher
Loose stopple type.
Solution Temperature 70°, 90°, 105°F.
Water 17 gals. Soda 10 Lbs. Acid 2½ Lbs.
Nozzle orifice 7/32 Inch.
Note: Strainer 40-5/32 Inch holes as made up for extinguisher 608.

Test No.13 -- 70°F
" " 11 -- 90°F
" " 12 --105°F
" " 15 -- 50°F

Pressure - Lbs per sq. in.

160
120
80
40

105°F
90°F
70°F
50°F

Time - Seconds.

40 80 120 160 200 240

Sheet 20.
Tests 12, 11, 13, 15.

UNIVERSAL CROSS SECTION 455

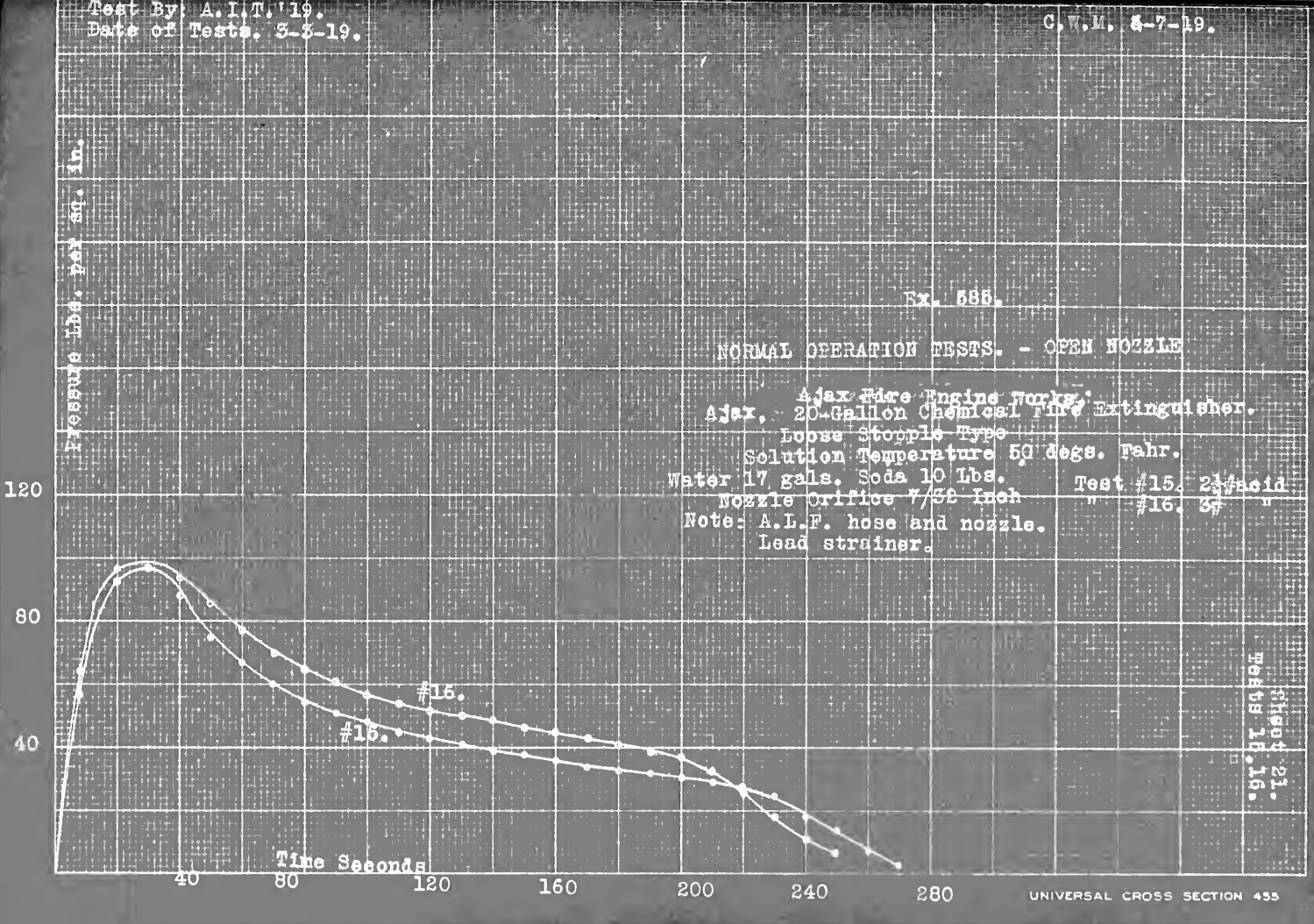
Test By: A.I.T. '19.
Date of Tests. 3-3-19.

C.W.M. 4-7-19.

Ex. 585.

NORMAL OPERATION TESTS. - OPEN NOZZLE

Ajax Fire Engine Works.
Ajax. 20-Gallon Chemical Fire Extinguisher.
Lobse Stopple Type
Solution Temperature 50 degs. Fahr.
Water 17 gals. Soda 10 Lbs. Test #15. 2¼# acid
Nozzle Orifice 7/32 Inch " #16. 3# "
Note: A.L.F. hose and nozzle.
Lead strainer.



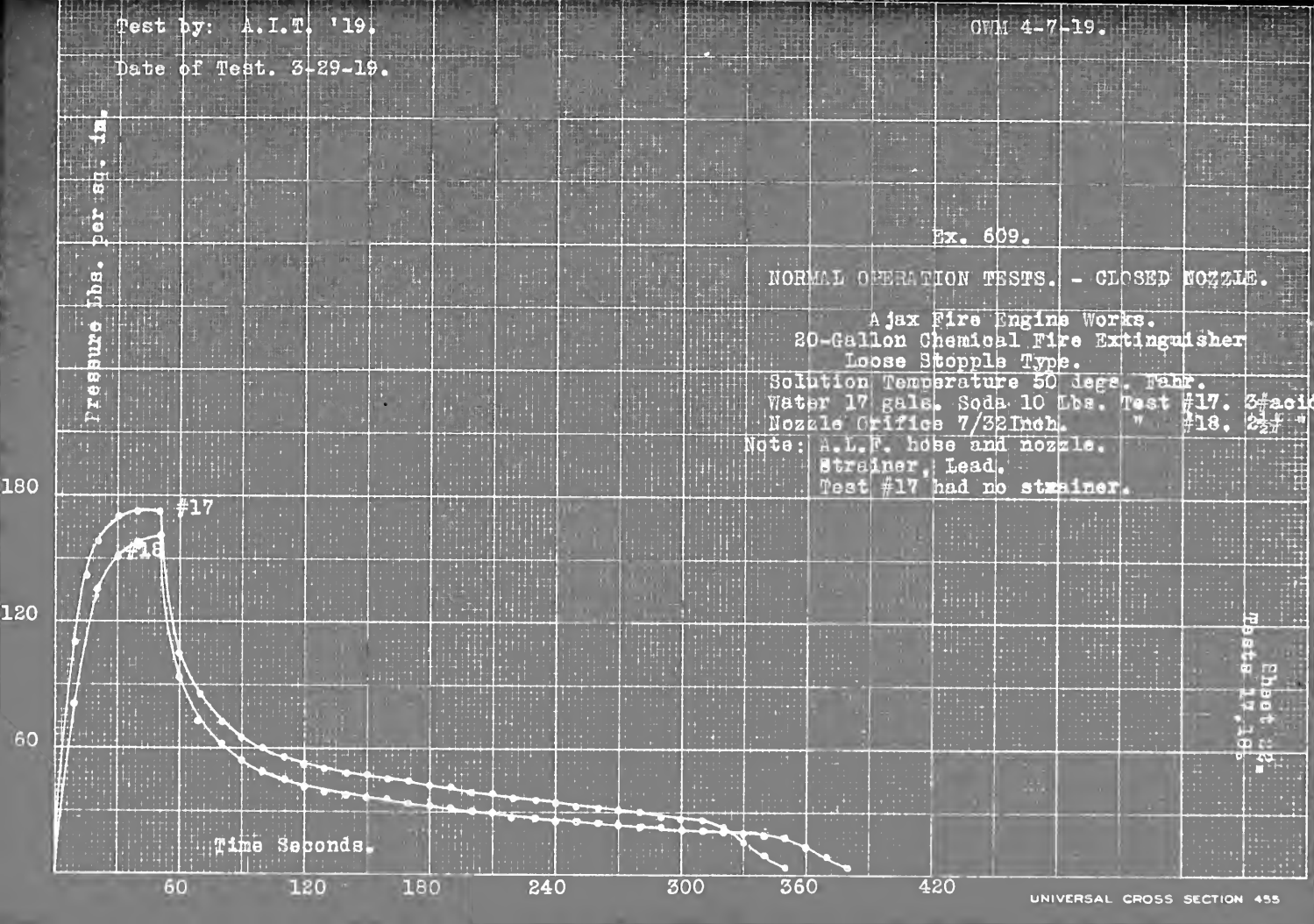
Test by: A.I.T. '19. OVM 4-7-19.

Date of Test. 3-29-19.

Ex. 609.

NORMAL OPERATION TESTS. - CLOSED NOZZLE.

Ajax Fire Engine Works.
20-Gallon Chemical Fire Extinguisher
Loose Stopple Type.
Solution Temperature 50 degs. Fahr.
Water 17 gals. Soda 10 Lbs. Test #17. 3/4 acid
Nozzle Orifice 7/32 Inch. " #18. 3/4 " "
Note: A.L.F. hose and nozzle.
Strainer, Lead.
Test #17 had no strainer.



Sheet No. 2.
Paste In. 18.

UNIVERSAL CROSS SECTION 455

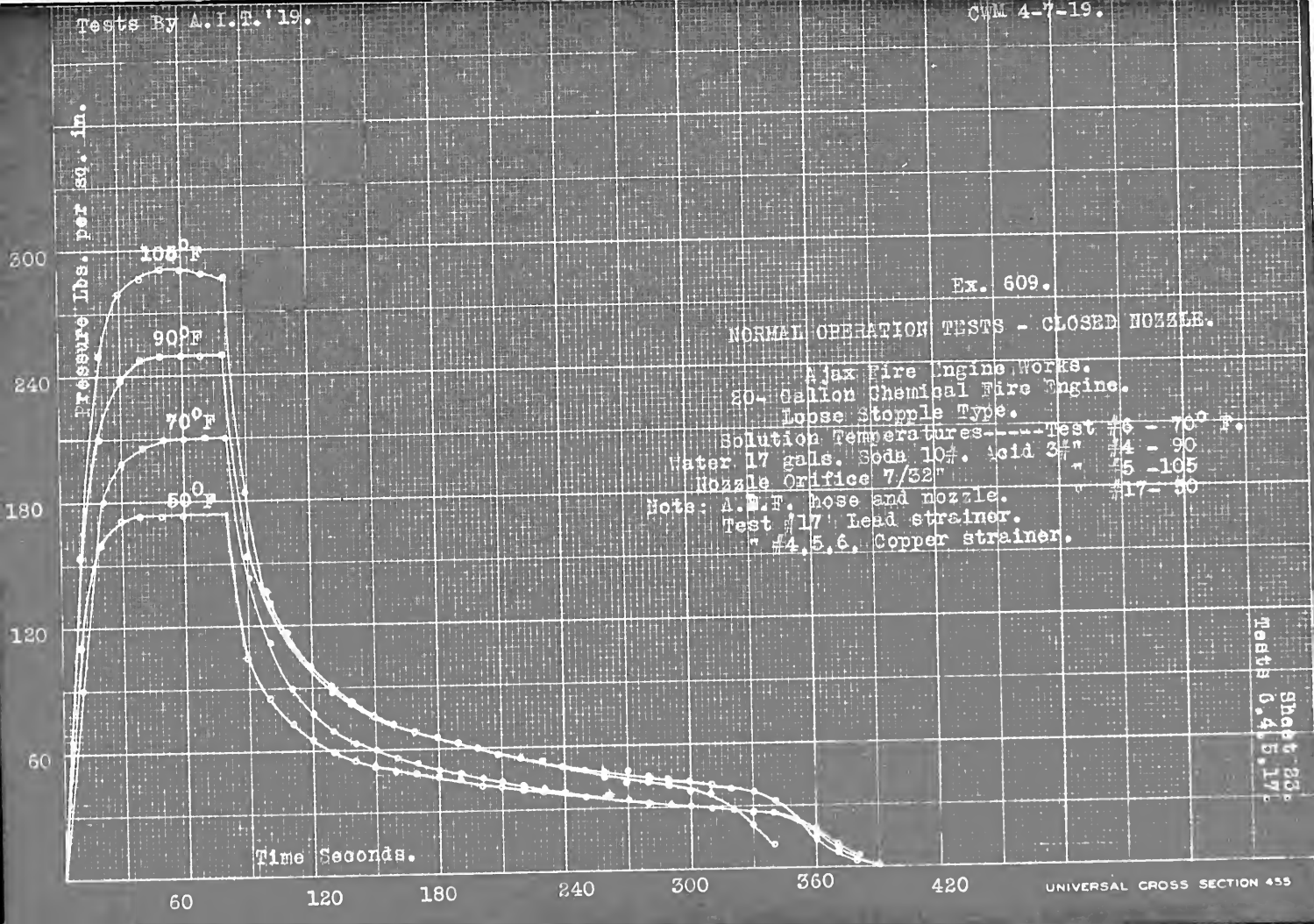
Tests By A.I.E. '19. CWM 4-7-19.

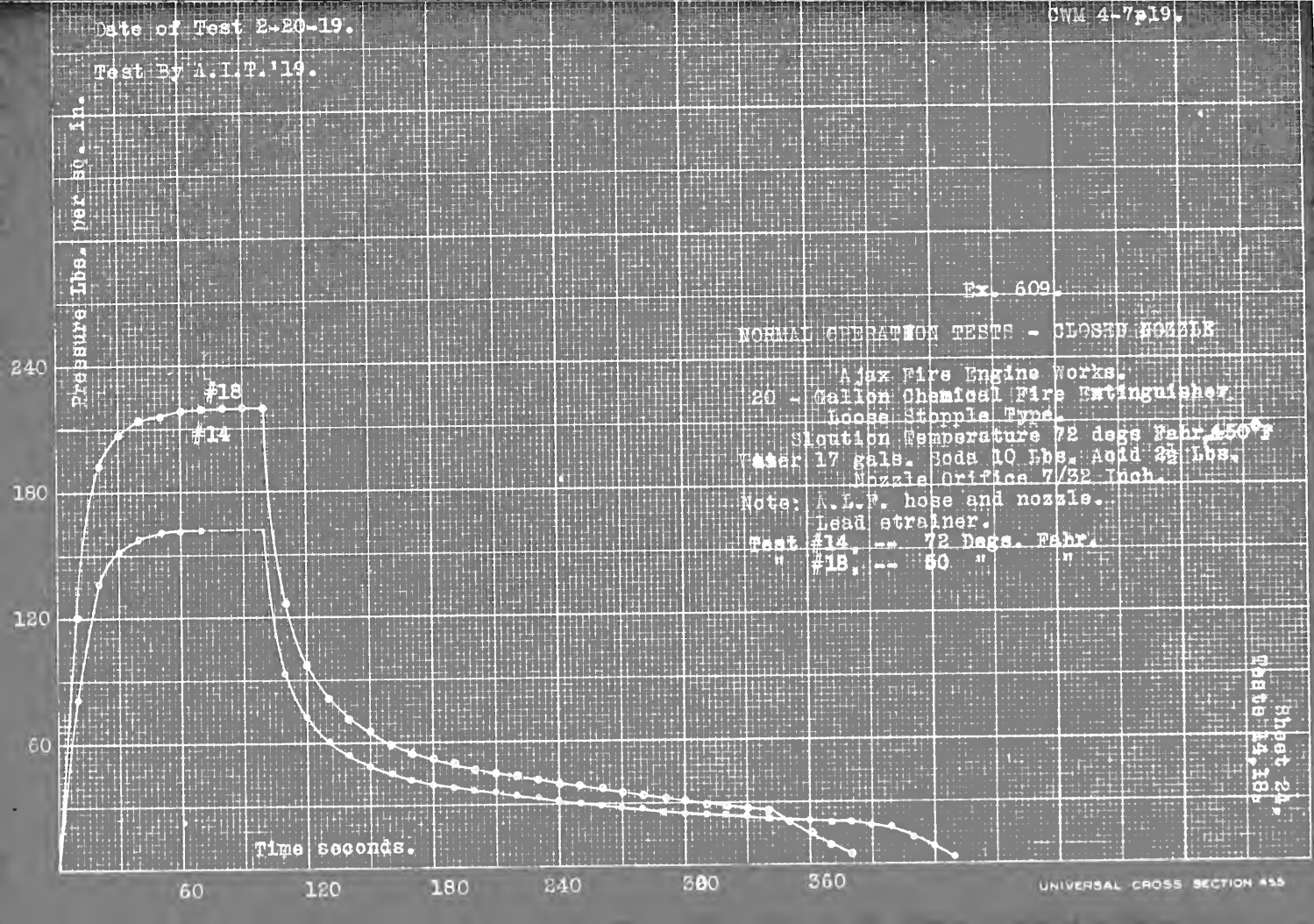
Ex. 609.

NORMAL OPERATION TESTS - CLOSED NOZZLE.

Ajax Fire Engine Works.
20- Gallon Chemical Fire Engine.
Loose Stopple Type.
Solution Temperatures-----Test #6 - 70° F.
Water 17 gals. Soda 10#. Acid 3#" " #4 - 90
Nozzle Orifice 7/32" " #5 -105
" #17- 50

Note: A.E.F. hose and nozzle.
Test #17 Lead strainer.
" #4.5.6. Copper strainer.




Date of Test 2-20-19.
Test By A.I.F.'19.
CWM 4-7-19.
Ex. 609.
NORMAL OPERATION TESTS - CLOSED NOZZLE
Ajax Fire Engine Works.
20 - Gallon Chemical Fire Extinguisher.
Loose Stopple Type.
Solution Temperature 72 degs Fahr. 150°F
Water 17 gals. Soda 10 Lbs. Acid 2½ Lbs.
Nozzle Orifice 7/32 Inch.
Note: A.L.F. hose and nozzle.
Lead strainer.
Test #14, -- 72 Degs. Fahr.
" #18, -- 50 " "
#18
#14
Pressure Lbs. per Sq. In.
240
180
120
60
Time seconds.
60
120
180
240
300
360
Sheet 24.
UNIVERSAL CROSS SECTION 455

Date of test. 2-3-19.

Ex. 609.

NORMAL OPERATION TESTS-CLOSED Nozzle

Ajax Fire Engine Works.
20- Gallon Chemical Fire Extinguishers.
Loose stopple type.
Solution Temperature 90 Degs. Fahr.
Water 17 gals. Soda 10 Lbs. Acid 3 Lbs.
ALF Nozzle Orifice 7/32 Inch.
Regular perforated copper strainer.
NOTE: Stopple failed to fall away until machine was righted and tipped over again.

Pressure - Lbs. per sq. in.

240
180
120
60

Time in Seconds.

60 120 180 240 300 360 420 480

Sheet 25. Tests 4.

UNIVERSAL CROSS SECTION 455

Tests by: A.I.T. '19.

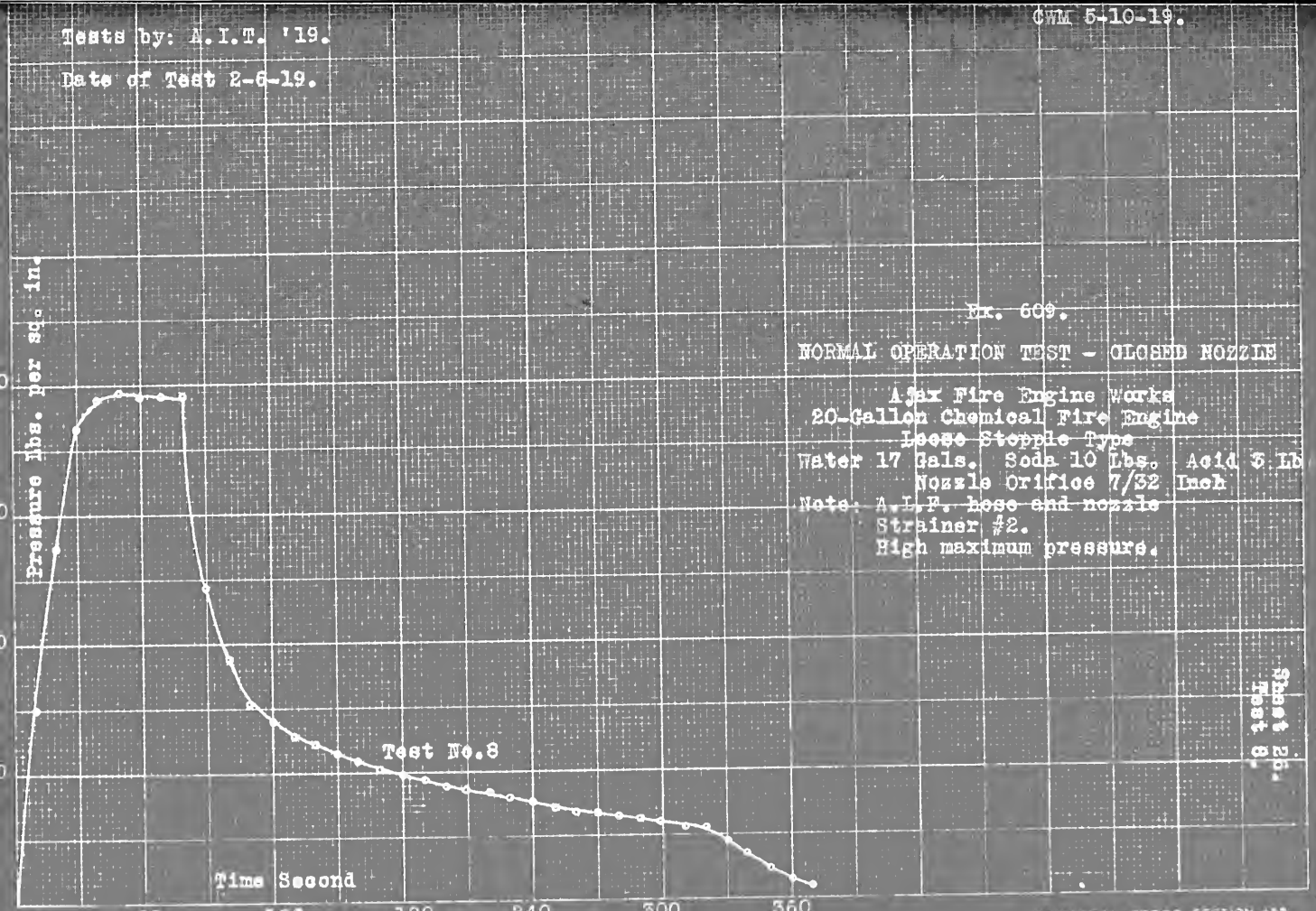
Date of Test 2-6-19.

CWM 5-10-19.

Ex. 609.

NORMAL OPERATION TEST - CLOSED NOZZLE

Ajax Fire Engine Works
20-Gallon Chemical Fire Engine
Loose Stopple Type
Water 17 Gals. Soda 10 Lbs. Acid 5 Lb
Nozzle Orifice 7/32 Inch
Note: A.L.F. hose and nozzle
Strainer #2.
High maximum pressure.



Sheet 2b.

UNIVERSAL CROSS SECTION 455

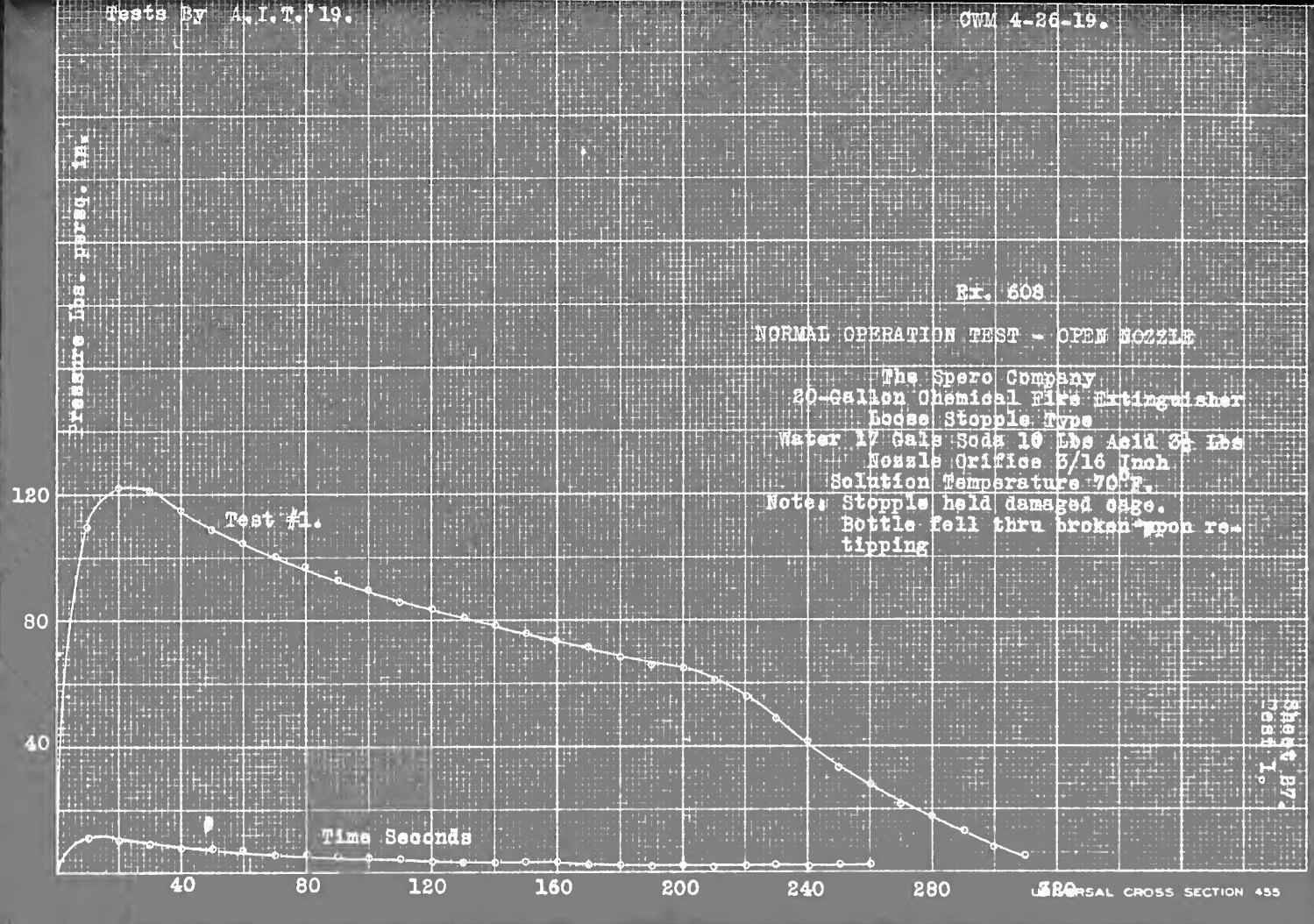
Tests By A.I.T. '19.

CWM 4-26-19.

Ex. 608

NORMAL OPERATION TEST - OPEN NOZZLE

The Spero Company
20-Gallon Chemical Fire Extinguisher
Loose Stopple Type
Water 17 Gals Soda 10 Lbs Acid 3½ Lbs
Nozzle Orifice 5/16 Inch
Solution Temperature 70° F.
Notes Stopple held damaged cage.
Bottle fell thru broken upon re-tipping



Sheet #74
Test I.

UNIVERSAL CROSS SECTION 455

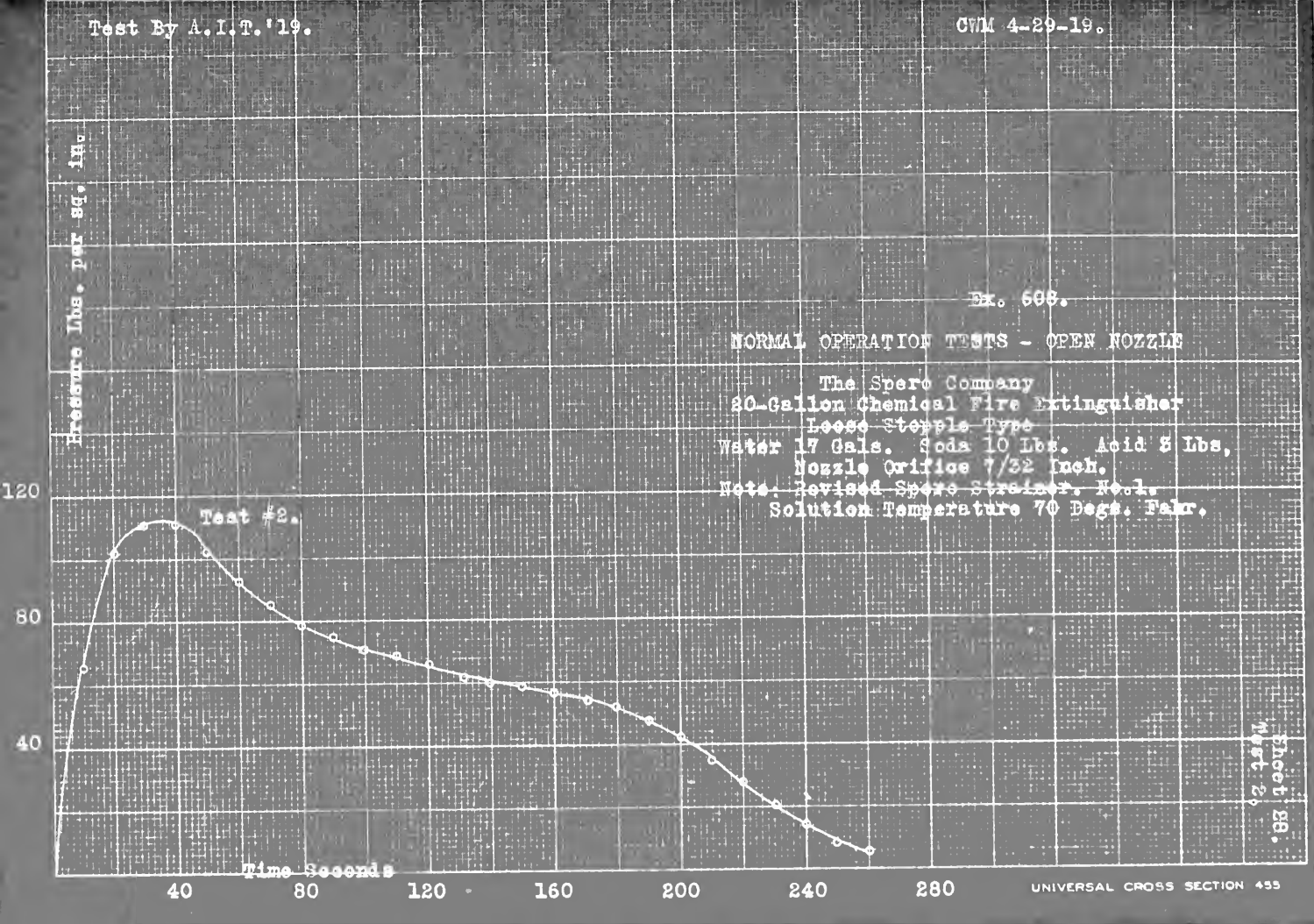
Test By A.I.T.'19.

CWM 4-29-19.

Ex. 608.

NORMAL OPERATION TESTS - OPEN NOZZLE

The Spero Company
20-Gallon Chemical Fire Extinguisher
Loose Stopple Type
Water 17 Gals. Soda 10 Lbs. Acid 8 Lbs.
Nozzle Orifice 7/32 Inch.
Note: Revised Spero Strainer. Used.
Solution Temperature 70 Degs. Fahr.



Test By A.I.T. '19.

CWM 4-26019.

Ex. 608.

NORMAL OPERATION TESTS - OPEN NOZZLE

The Spero Company
20- Gallon Chemical Fire Extinguisher
Loose Stopple Type
Water 17 Gals Soda 10 Lbs Acid 8 Lbs.
Nozzle Orifice 7/32 Inch

Test #31 -- 45°F
" #4 -- 70°
" #5 -- 90°
" #15 -- 105°

Pressure Lbs. per sq. in.

160
120
80
40

105°F
90°F
70°F
45°

Time Seconds

40 80 120 160 200 240 280

Sheet 49.
Tests 31, 4, 5, 15.

UNIVERSAL CROSS SECTION 455

Tests By A.I.T.'19.

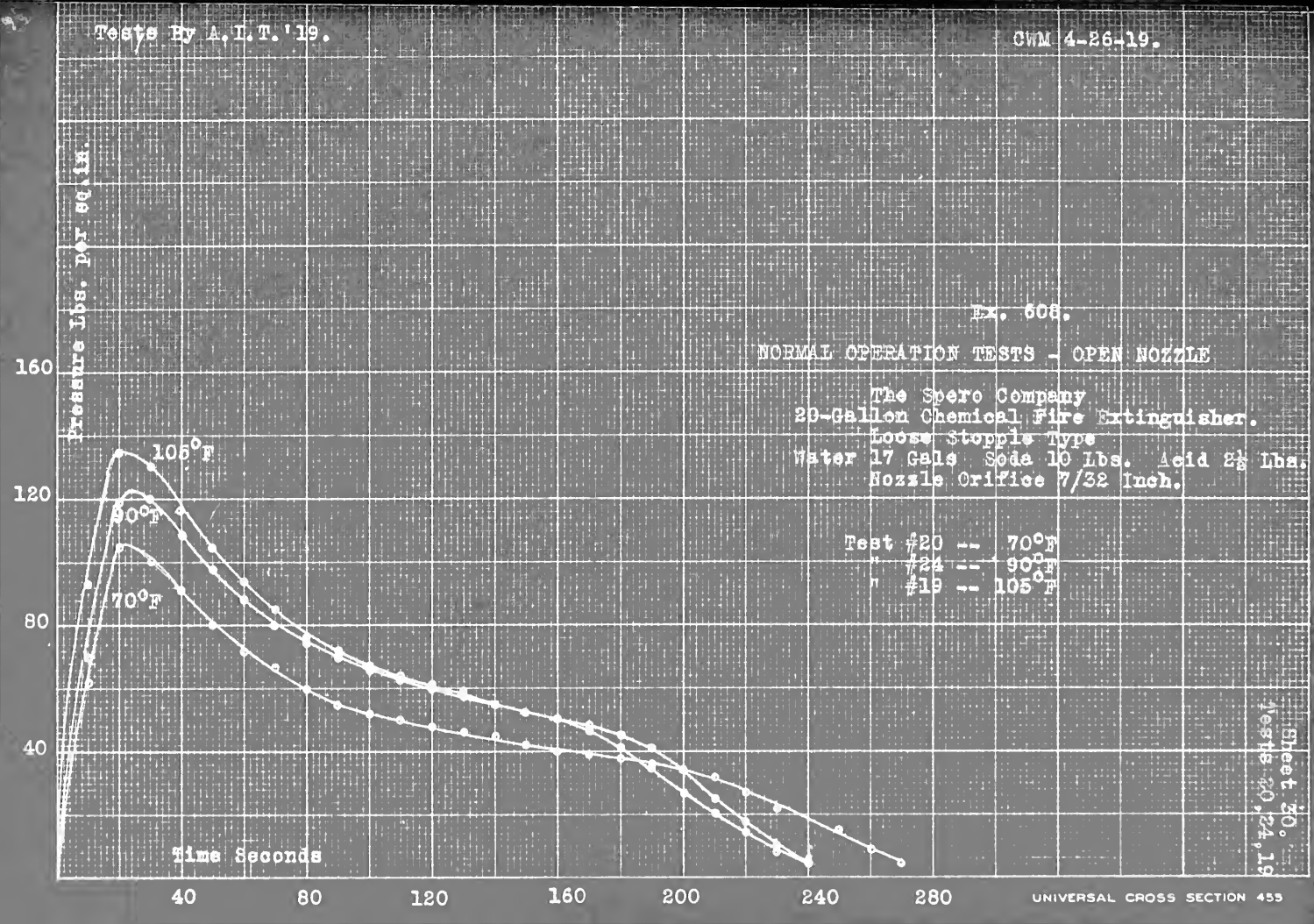
CWM 4-26-19.

Ex. 608.

NORMAL OPERATION TESTS - OPEN NOZZLE

The Spero Company
20-Gallon Chemical Fire Extinguisher.
Loose Stopple Type
Water 17 Gals Soda 10 Lbs. Acid 2½ Lbs.
Nozzle Orifice 7/32 Inch.

Test #20 -- 70°F
" #24 -- 90°F
" #19 -- 105°F



Sheet 20.
Tests 20, 24, 19

Test By A.I.E.'19.

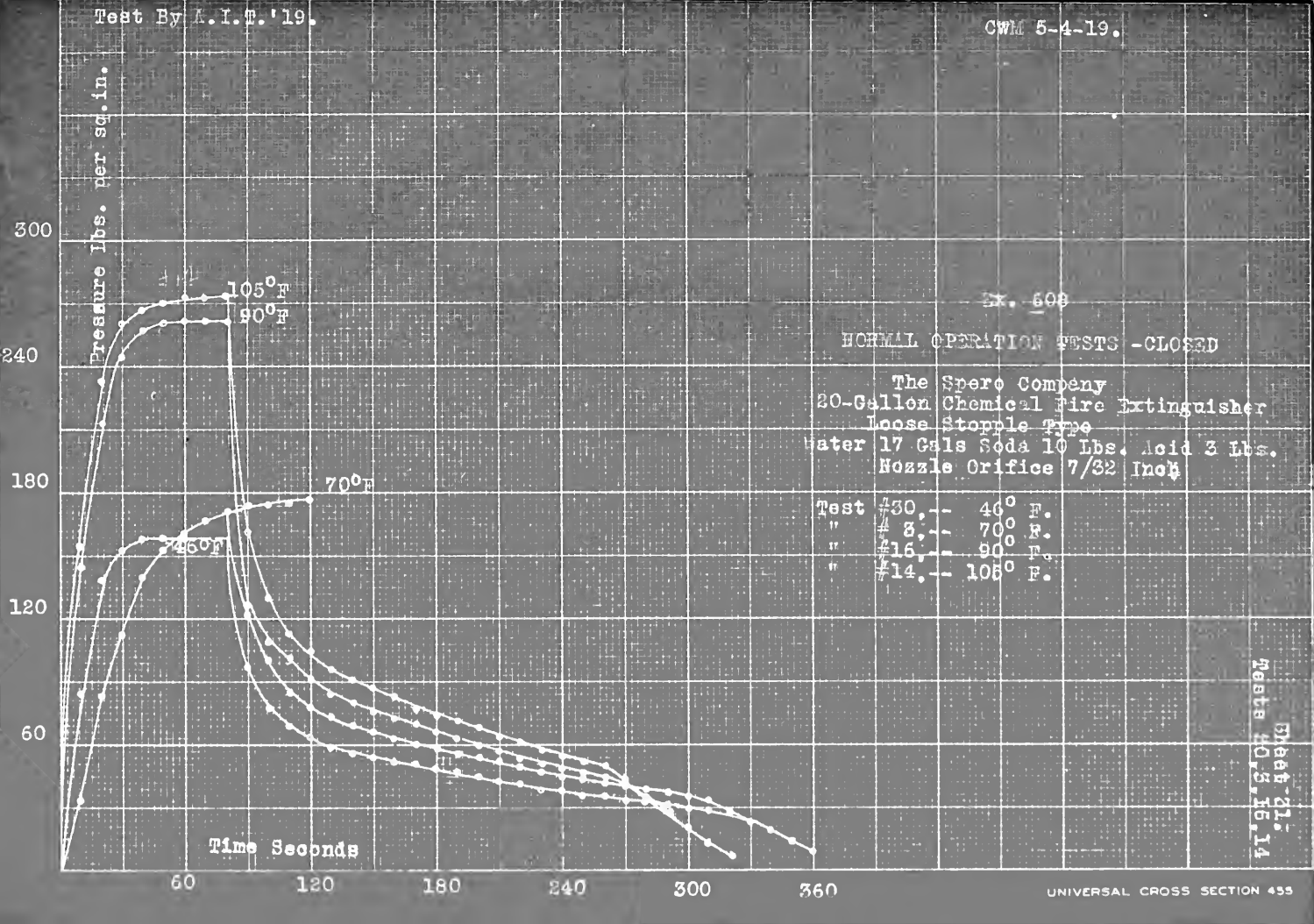
CWM 5-4-19.

Ex. 608

NORMAL OPERATION TESTS -CLOSED

The Spero Company
20-Gallon Chemical Fire Extinguisher
Loose Stopple Type
Water 17 Gals Soda 10 Lbs. Acid 3 Lbs.
Nozzle Orifice 7/32 Inch

Test #30.-- 46° F.
" # 8.-- 70° F.
" #16.-- 90° F.
" #14.-- 105° F.



Sheet 21.
Tests #0,3,16,14

UNIVERSAL CROSS SECTION 455

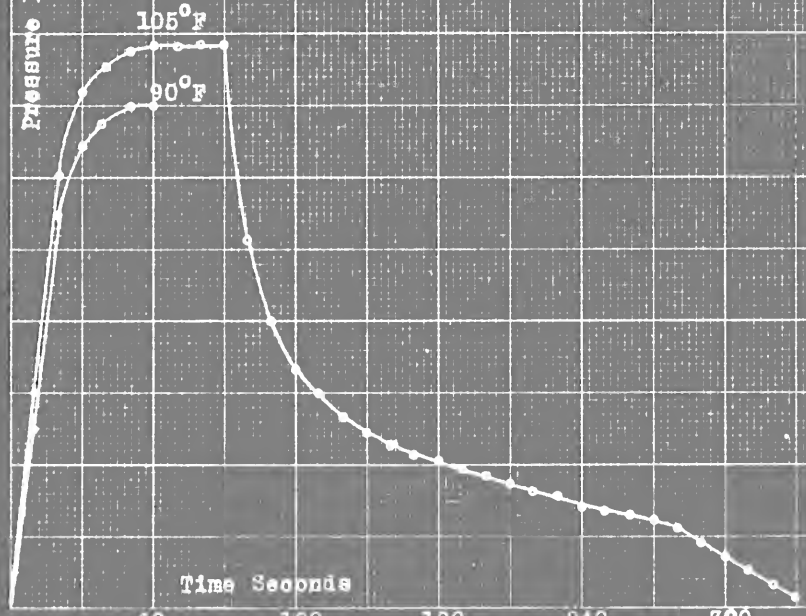
Tests by A.I.T.'19.

CWM 5-12-19.

Ex. 608

NORMAL OPERATION TESTS - CLOSED NOZZLE

The Spero Company
20 Gallon Chemical Fire Engine
Loose Stopple Type
Water 17 Gals. Soda 10 Lbs. Acid 2½ Lbs
Nozzle Orifice 7/32 Inch
Test 22,- 90°F
" 21,-105°F
Note: Coupling blew off gauge hose.
Maximum pressure had been reached



Sheet No. 53
Tests 22, 21.

UNIVERSAL CROSS SECTION 455

Tests By A.E.T. '19.

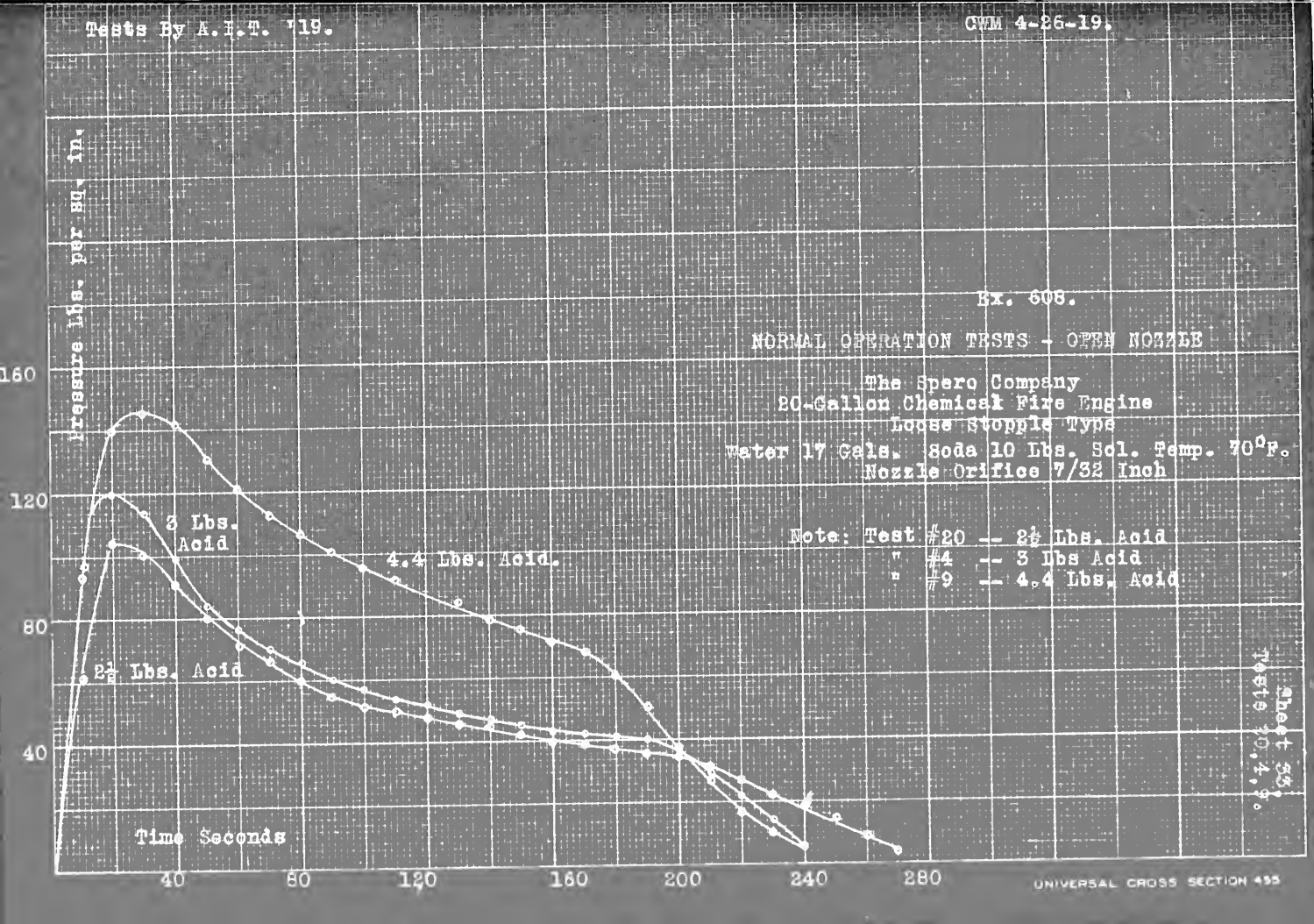
CWM 4-26-19.

Ex. 608.

NORMAL OPERATION TESTS - OPEN NOZZLE

The Spero Company
20-Gallon Chemical Fire Engine
Loose Stopple Type
Water 17 Gals. Soda 10 Lbs. Sol. Temp. 70°F.
Nozzle Orifice 7/32 Inch

Note: Test #20 -- 2½ Lbs. Acid
" #4 -- 3 Lbs Acid
" #9 -- 4.4 Lbs. Acid



Sheet 33, Tests 20, 4, 9.

Tests By A.I.T.'19.

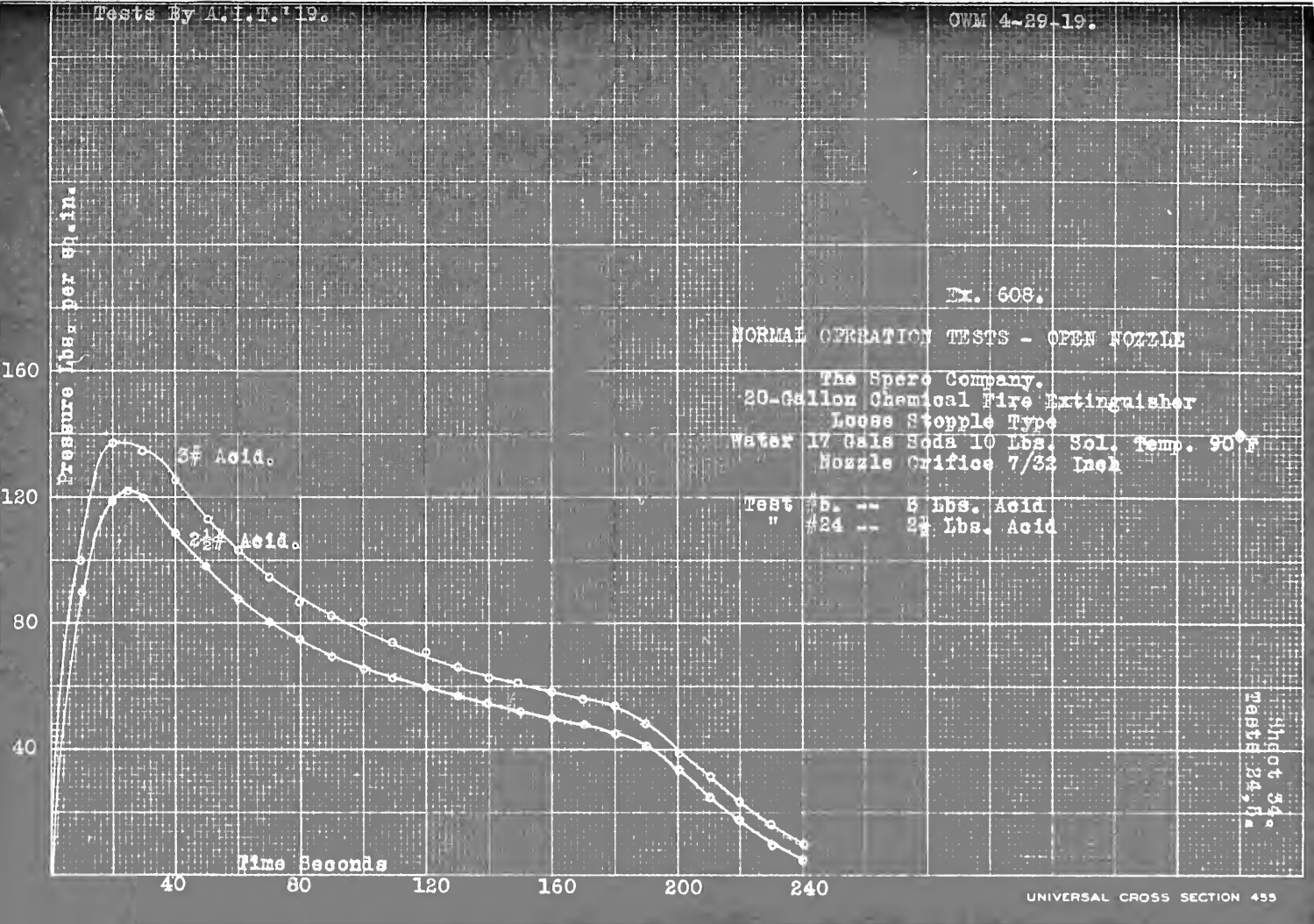
OWM 4-29-19.

Ex. 608.

NORMAL OPERATION TESTS - OPEN NOZZLE

The Spero Company.
20-Gallon Chemical Fire Extinguisher
Loose Stopple Type
Water 17 Gals Soda 10 Lbs. Sol. Temp. 90°F
Nozzle Orifice 7/32 Inch

Test #5. -- 3 Lbs. Acid
" #24 -- 2½ Lbs. Acid



UNIVERSAL CROSS SECTION 455

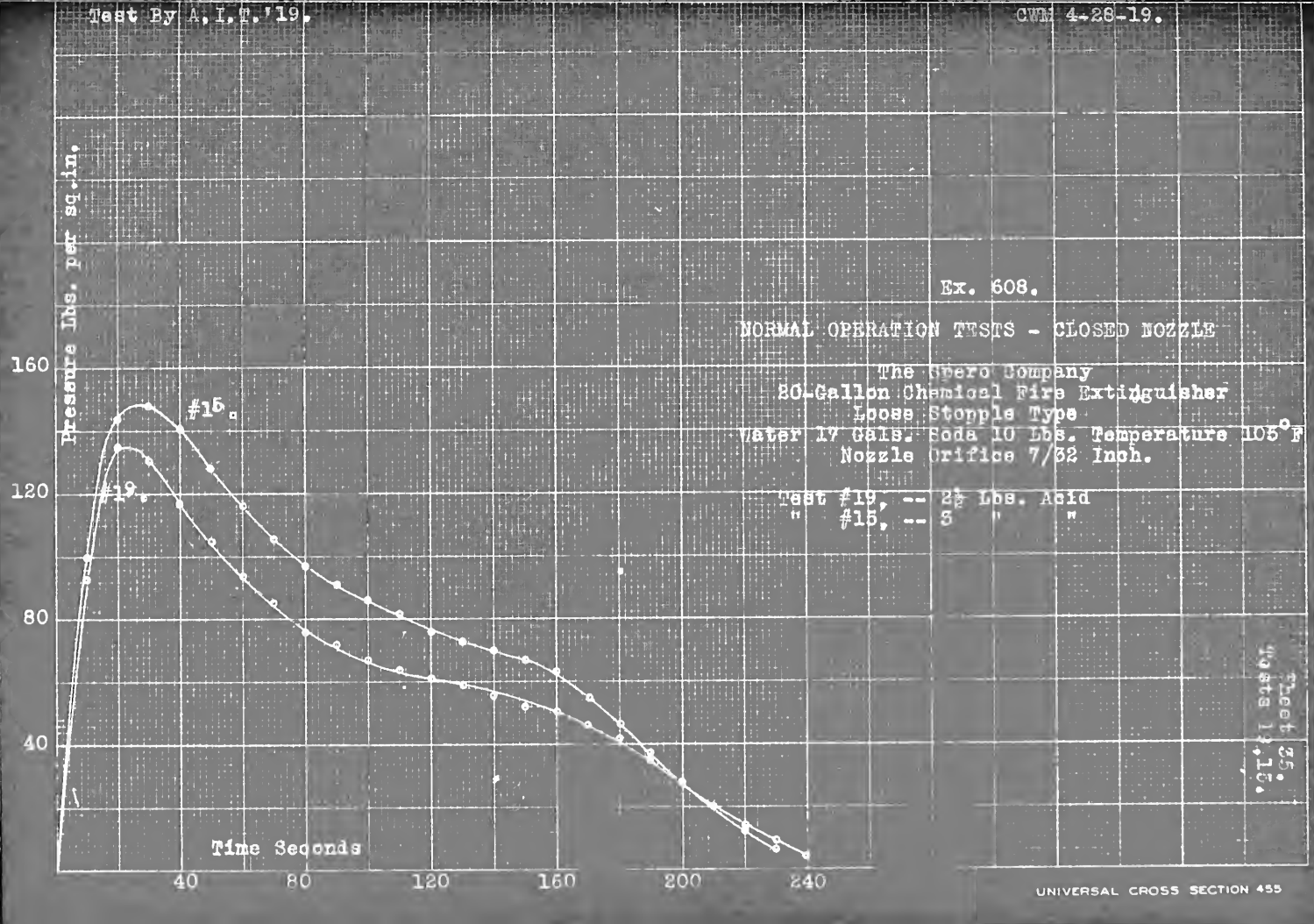
Test By A.I.T.'19. CWM 4-28-19.

Ex. 608.

NORMAL OPERATION TESTS - CLOSED NOZZLE

The Spero Company
80-Gallon Chemical Fire Extinguisher
Loose Stopple Type
Water 17 Gals. Soda 10 Lbs. Temperature 105°F
Nozzle Orifice 7/32 Inch.

Test #19, -- 2½ Lbs. Acid
" #15, -- 3 " "



Sheet 35.
Tests 1 to 13.

UNIVERSAL CROSS SECTION 455

Test By A.I.T.'19.

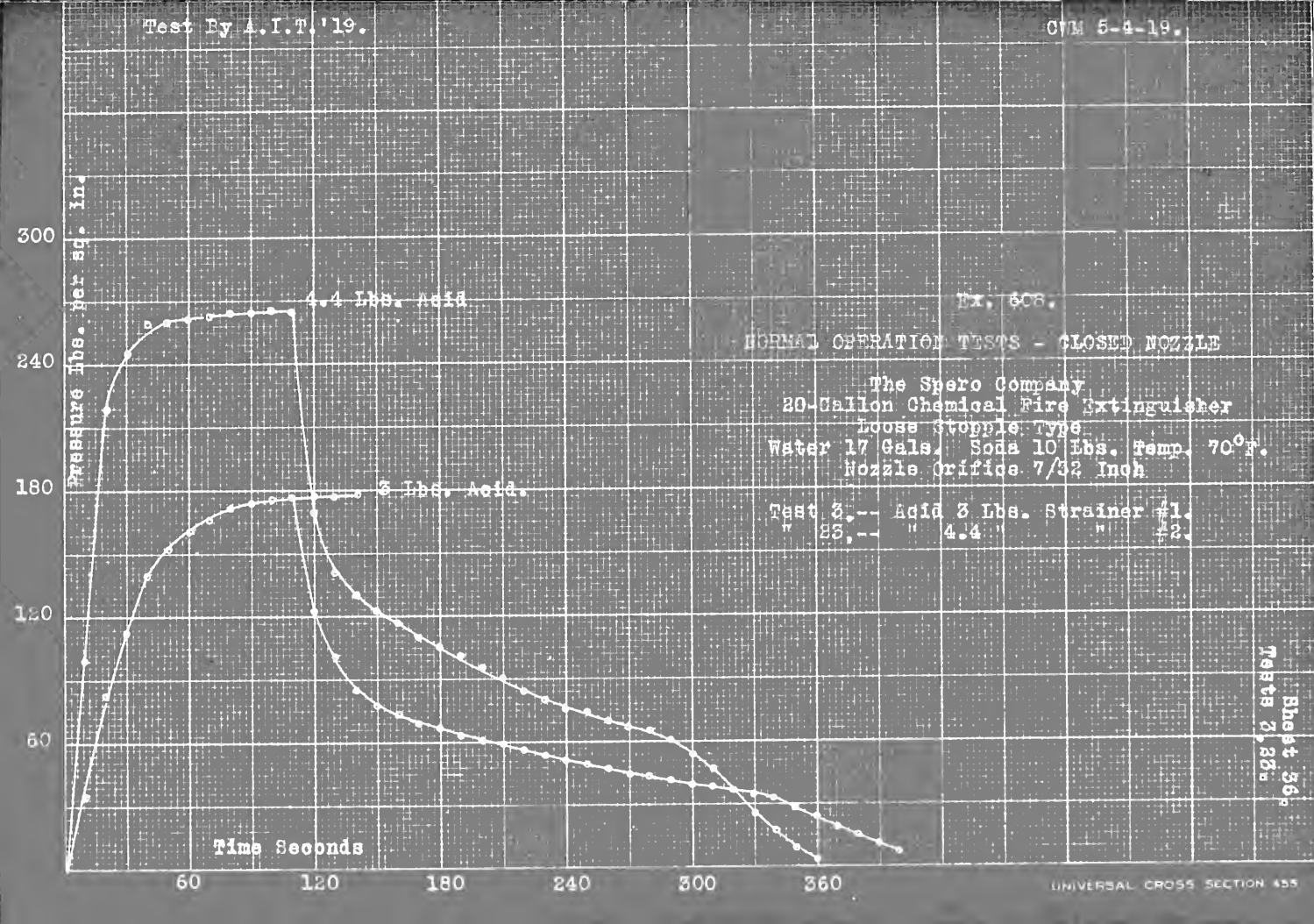
CVM 5-4-19.

Ex. 608.

NORMAL OPERATION TESTS - CLOSED NOZZLE

The Spero Company
20-Gallon Chemical Fire Extinguisher
Loose Stopple Type
Water 17 Gals. Soda 10 Lbs. Temp. 70°F.
Nozzle Orifice 7/32 Inch

Test 3.-- Acid 3 Lbs. Strainer #1.
" 23.-- " 4.4 " " #2.



Tests 21,22a Sheet 36a

UNIVERSAL CROSS SECTION 455

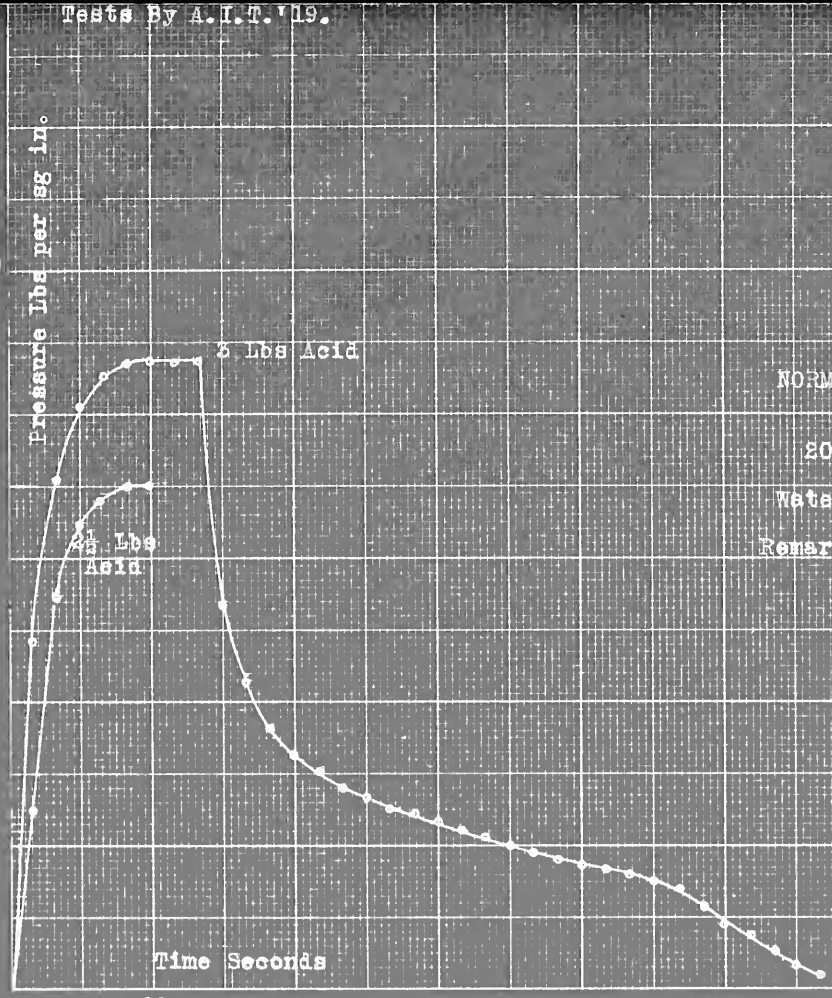
Tests By A.I.T.'19. CWM 4-26-19.

Ex. 608.

NORMAL OPERATION TESTS - CLOSED NOZZLE

The Spero Company
20-Gallon Chemical Fire Extinguisher
Loose Stopple Type
Water 17 Gals Soda 10 Lbs. Sol. Temp. 90°F
Nozzle Orifice 7/32 Inch
Remarks. Test #23. Nozzle blew off after maximum pressure was reached

Test #16 -- 3 Lbs Acid
" #22 -- 2½ Lbs Acid

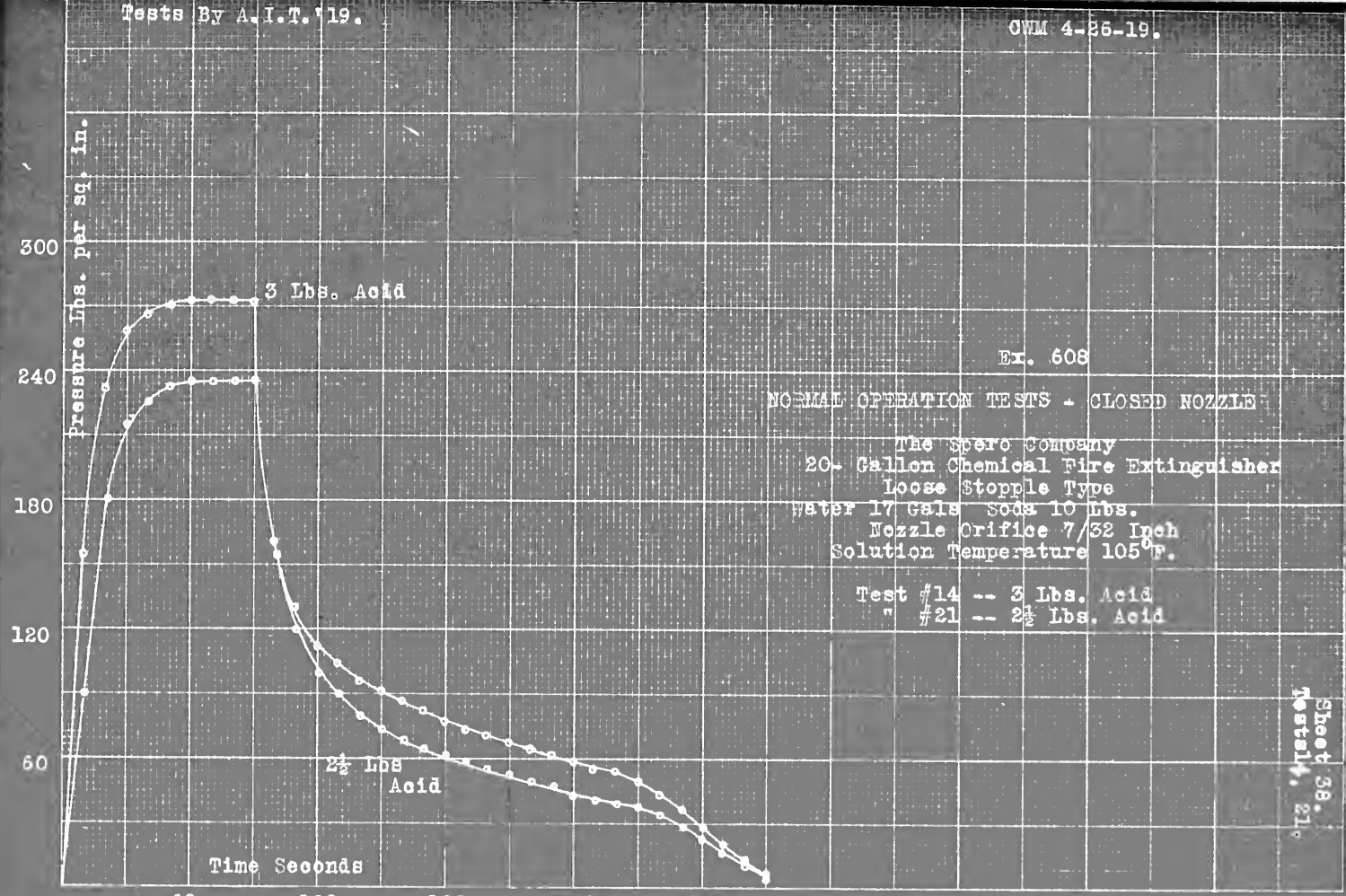


Tests 16. 22. Sheet 37.

UNIVERSAL CROSS SECTION 455

Tests By A.I.T. '19.

CWM 4-26-19.



Ex. 608

NORMAL OPERATION TESTS - CLOSED NOZZLE

The Spero Company
20- Gallon Chemical Fire Extinguisher
Loose Stopple Type
Water 17 Gals Soda 10 Lbs.
Nozzle Orifice 7/32 Inch
Solution Temperature 105° F.

Test #14 -- 3 Lbs. Acid
" #21 -- 2½ Lbs. Acid

Sheet 38.
Tests 14, 21.

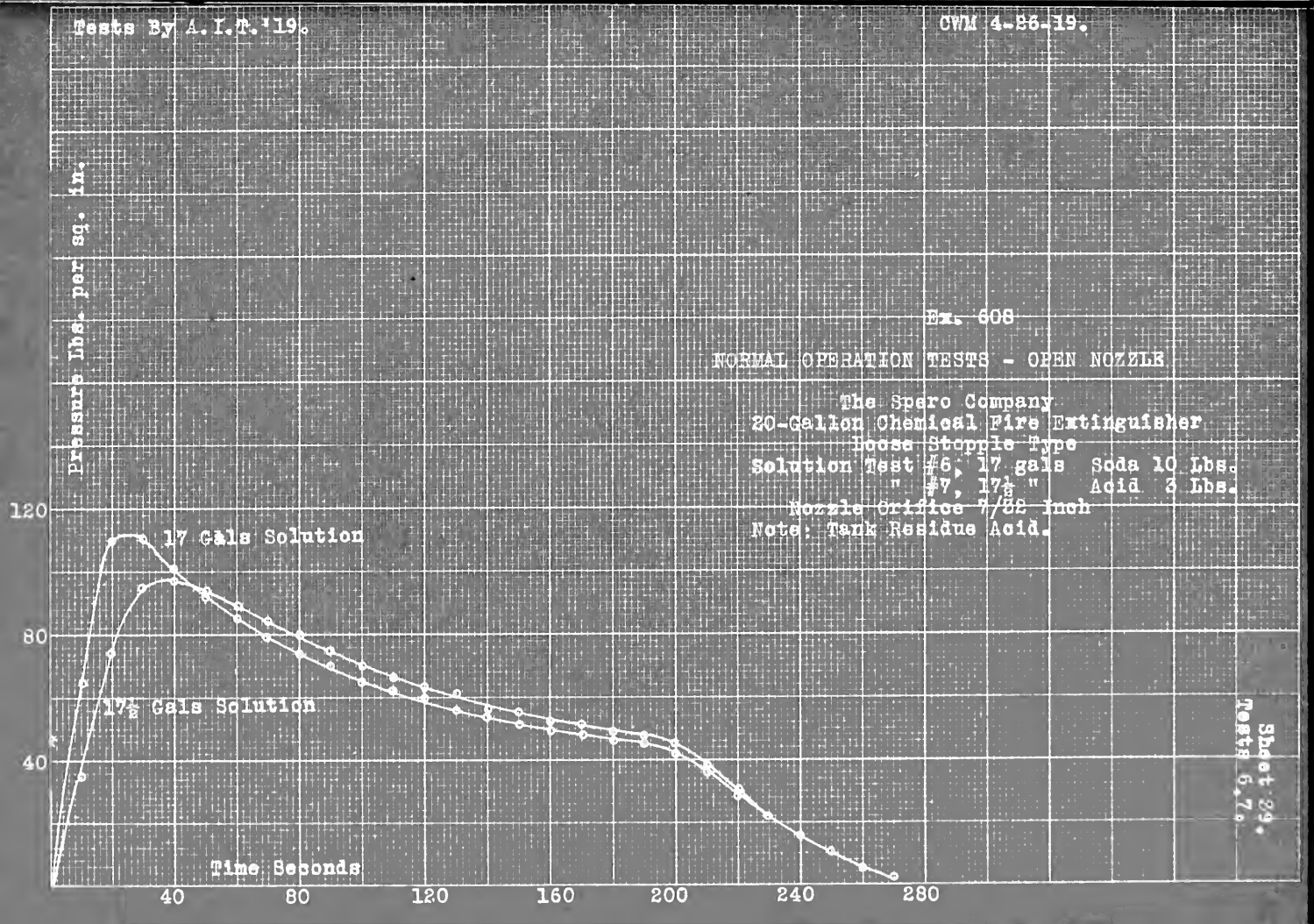
Tests By A.I.T.'19.

CWM 4-26-19.

Ex. 608

NORMAL OPERATION TESTS - OPEN NOZZLE

The Spero Company
20-Gallon Chemical Fire Extinguisher
Loose Stopple Type
Solution Test #6, 17 gals Soda 10 Lbs.
" #7, 17⅛ " Acid 3 Lbs.
Nozzle Orifice 7/32 Inch
Note: Tank Residue Acid.



Sheet 29.
Tests 6 & 7.

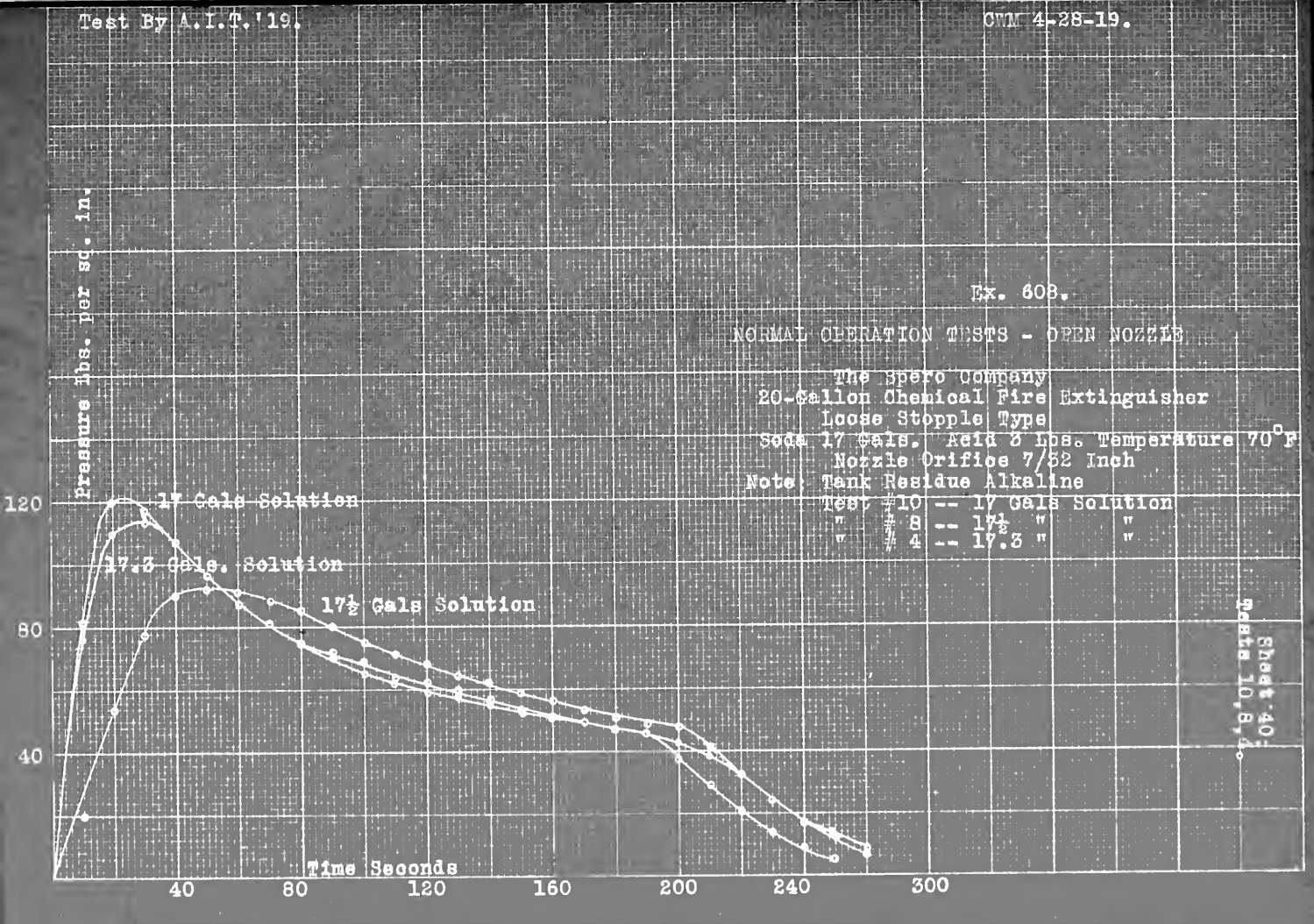
Test By A.I.T.'19.

CWT 4-28-19.

Ex. 608.

NORMAL OPERATION TESTS - OPEN NOZZLE

The Spero Company
20-Gallon Chemical Fire Extinguisher
Loose Stopple Type
Soda 17 Gals. Acid 3 Lbs. Temperature 70°F
Nozzle Orifice 7/32 Inch
Note: Tank Residue Alkaline
Test #10 -- 17 Gals Solution
" #8 -- 17½ " "
" #4 -- 17.3 " "



Sheet 40
Tests 10, 8, 4

Tests by A. I. T. '19.

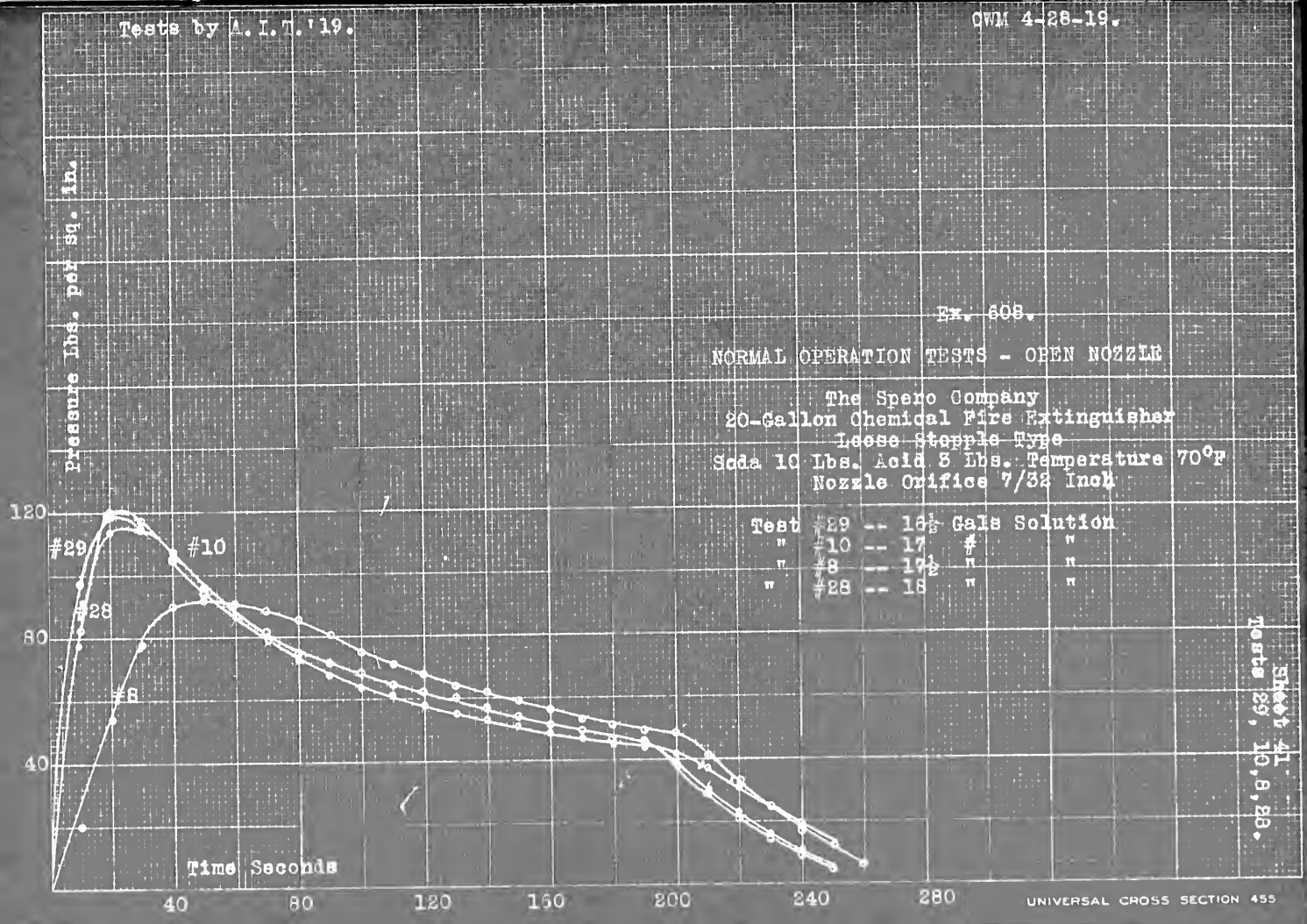
CWM 4-28-19.

Ex. 608.

NORMAL OPERATION TESTS - OPEN NOZZLE

The Spero Company
20-Gallon Chemical Fire Extinguisher
Loose Steeple Type
Soda 10 Lbs. Acid 8 Lbs. Temperature 70°F
Nozzle Orifice 7/32 Inch

Test #29 -- 16½ Gals Solution
" #10 -- 17 " "
" #8 -- 17½ " "
" #28 -- 18 " "

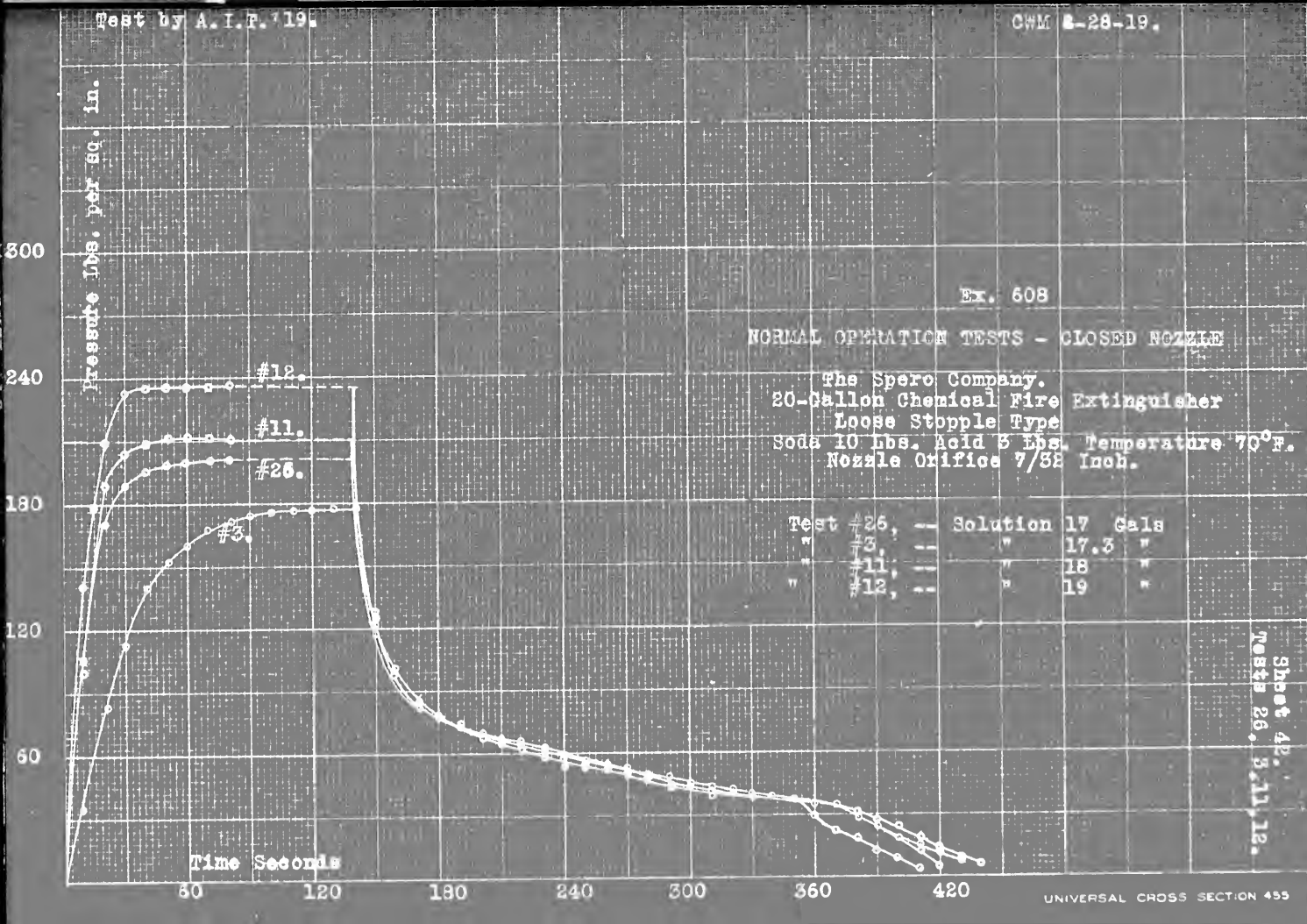


Sheet 41.
Tests 29, 10, 8, 28.

UNIVERSAL CROSS SECTION 455

Test by A.I.F. '19.

CWM 8-28-19.



Ex. 608

NORMAL OPERATION TESTS - CLOSED NOZZLE

The Spero Company.
20-Gallon Chemical Fire Extinguisher
Loose Stopple Type
Soda 10 Lbs. Acid 5 Lbs. Temperature 70°F.
Nozzle Orifice 7/32 Inch.

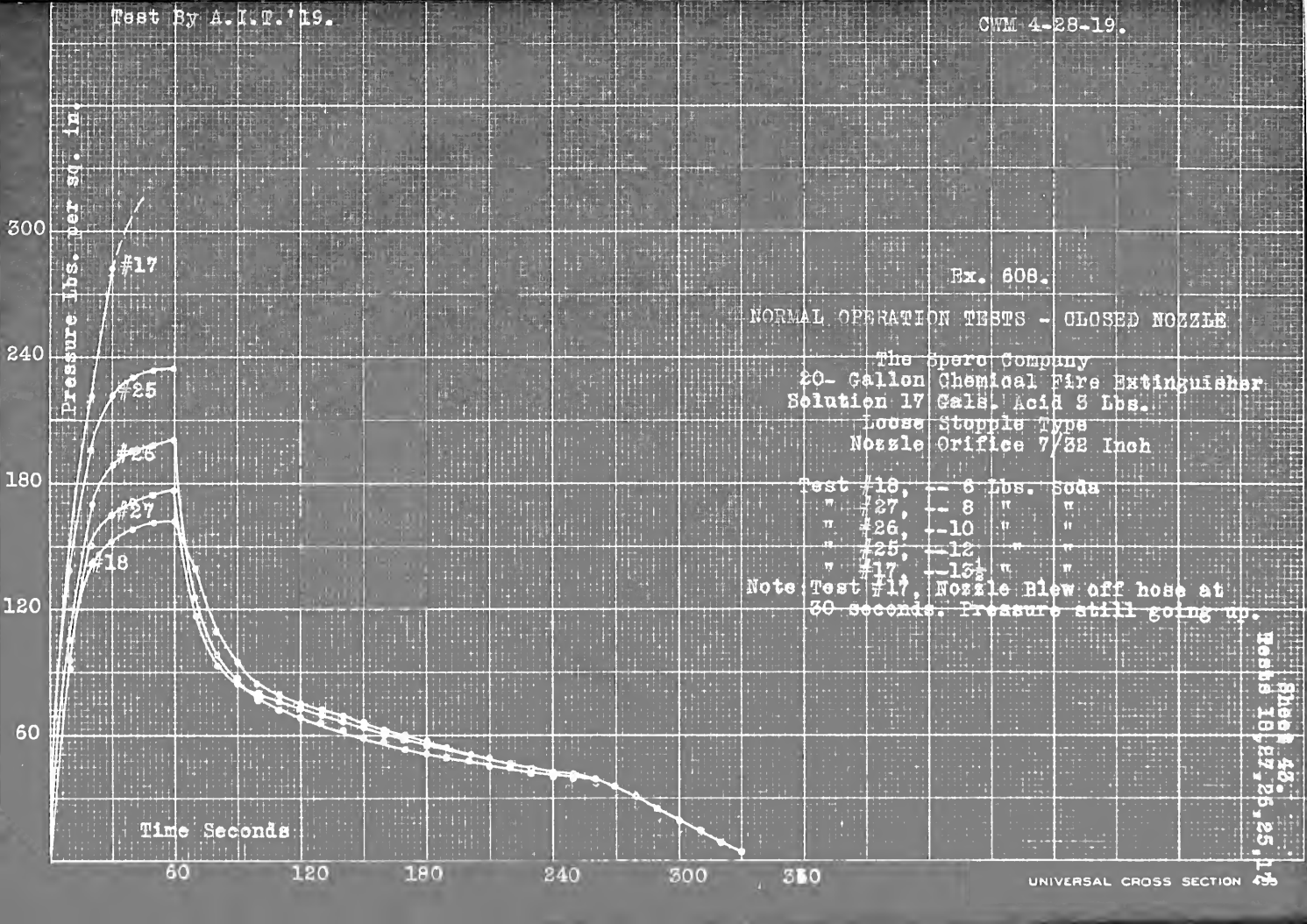
Test #26, -- Solution 17 Gals
" #3, -- " 17.3 "
" #11, -- " 18 "
" #12, -- " 19 "

Sheet 4p.
Tests 26, 3, 11, 12.

UNIVERSAL CROSS SECTION 455

Test By A.I.T. '19.

CWM 4-28-19.



Ex. 608.

NORMAL OPERATION TESTS - CLOSED NOZZLE

The Spero Company
20- Gallon Chemical Fire Extinguisher
Solution 17 Gals. Acid 8 Lbs.
Loose Stopple Type
Nozzle Orifice 7/32 Inch

Test #18, -- 6 Lbs. Soda
" #27, -- 8 " "
" #26, --10 " "
" #25, --12 " "
" #17, --13½ " "

Note: Test #17, Nozzle Blew off hose at 30 seconds. Pressure still going up.

Reads 18, 27, 26, 25, 17

Group 48.

UNIVERSAL CROSS SECTION

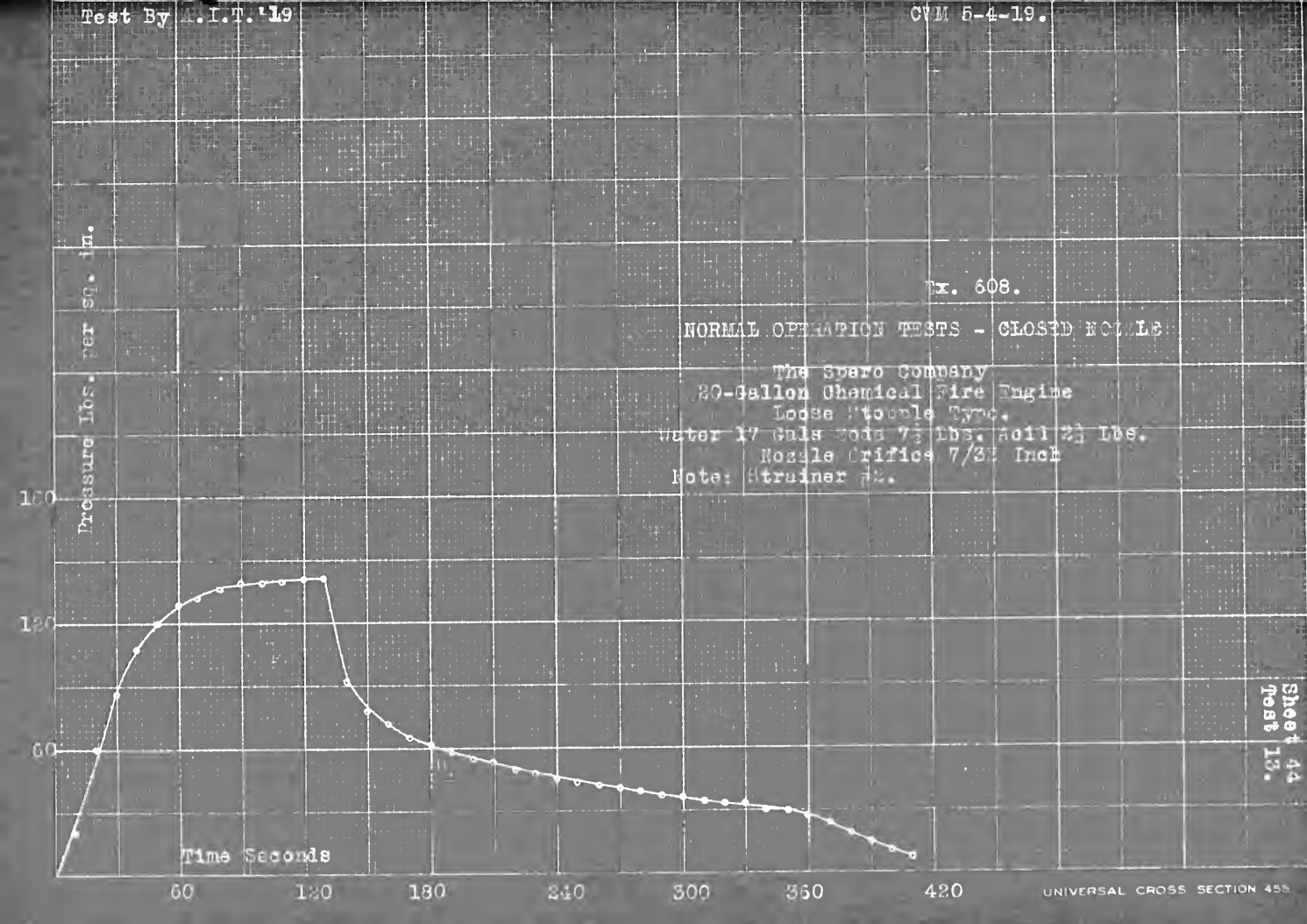
Test By A.I.T. '19

CVM 5-4-19.

Tx. 608.

NORMAL OPERATION TESTS - CLOSED NOZZLE

The Spero Company
20-Gallon Chemical Fire Engine
Loose Nozzle Type.
Water 17 Gals Soda 7½ Lbs. Acid 2½ Lbs.
Nozzle Orifice 7/32 Inch
Note: Strainer #2.



Sheet 44
Test 13.

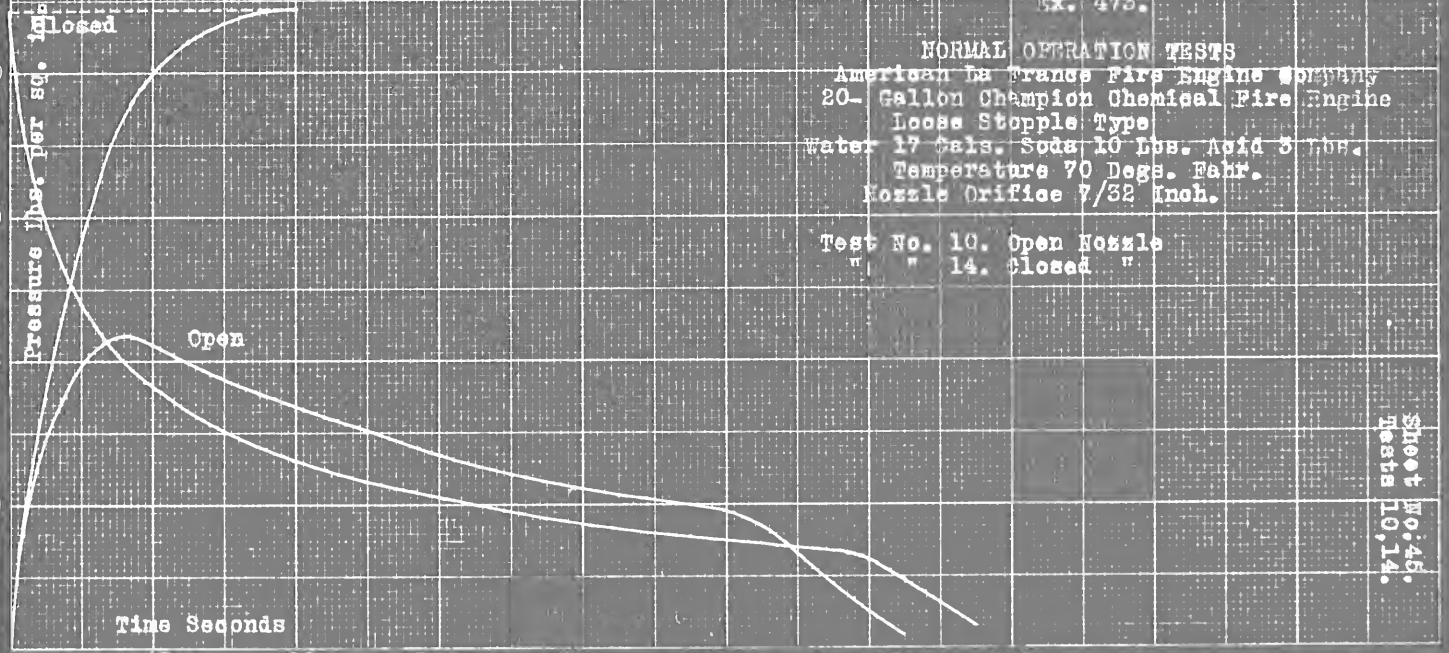
Tests by A.I.T.(19.

CWM 5-12-19.

Ex. 473.

NORMAL OPERATION TESTS
American La France Fire Engine Company
20- Gallon Champion Chemical Fire Engine
Loose Stopple Type
Water 17 Gals. Soda 10 Lbs. Acid 3 Lbs.
Temperature 70 Degs. Fahr.
Nozzle Orifice 7/32 Inch.

Test No. 10. Open Nozzle
" " 14. Closed "

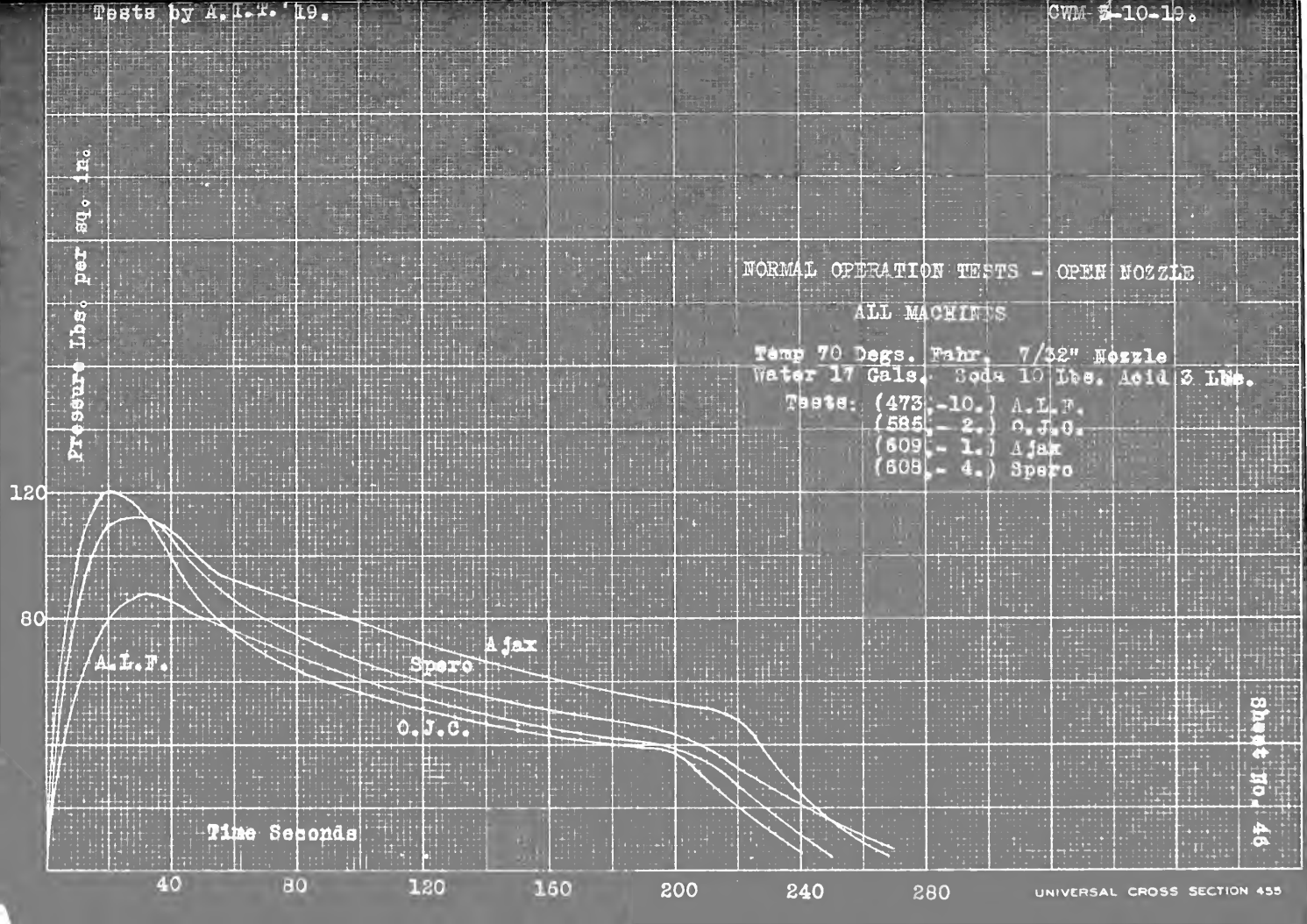


Sheet No.45.
Tests 10,14.

UNIVERSAL CROSS SECTION 455

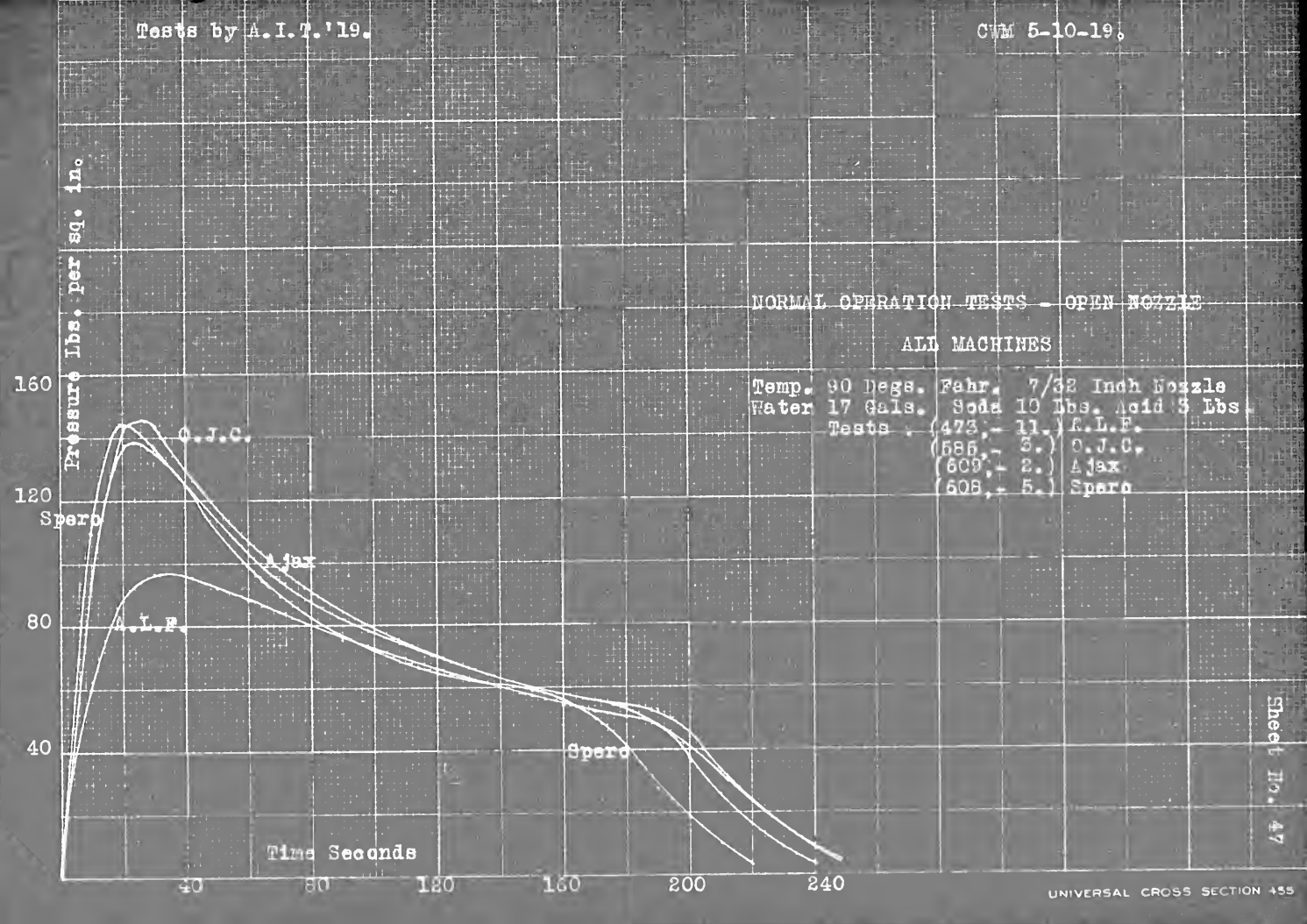
Tests by A.L.F. '19.

CWM 3-10-19.



Tests by A.I.T.'19.

CTM 5-10-19.



NORMAL OPERATION TESTS - OPEN NOZZLE

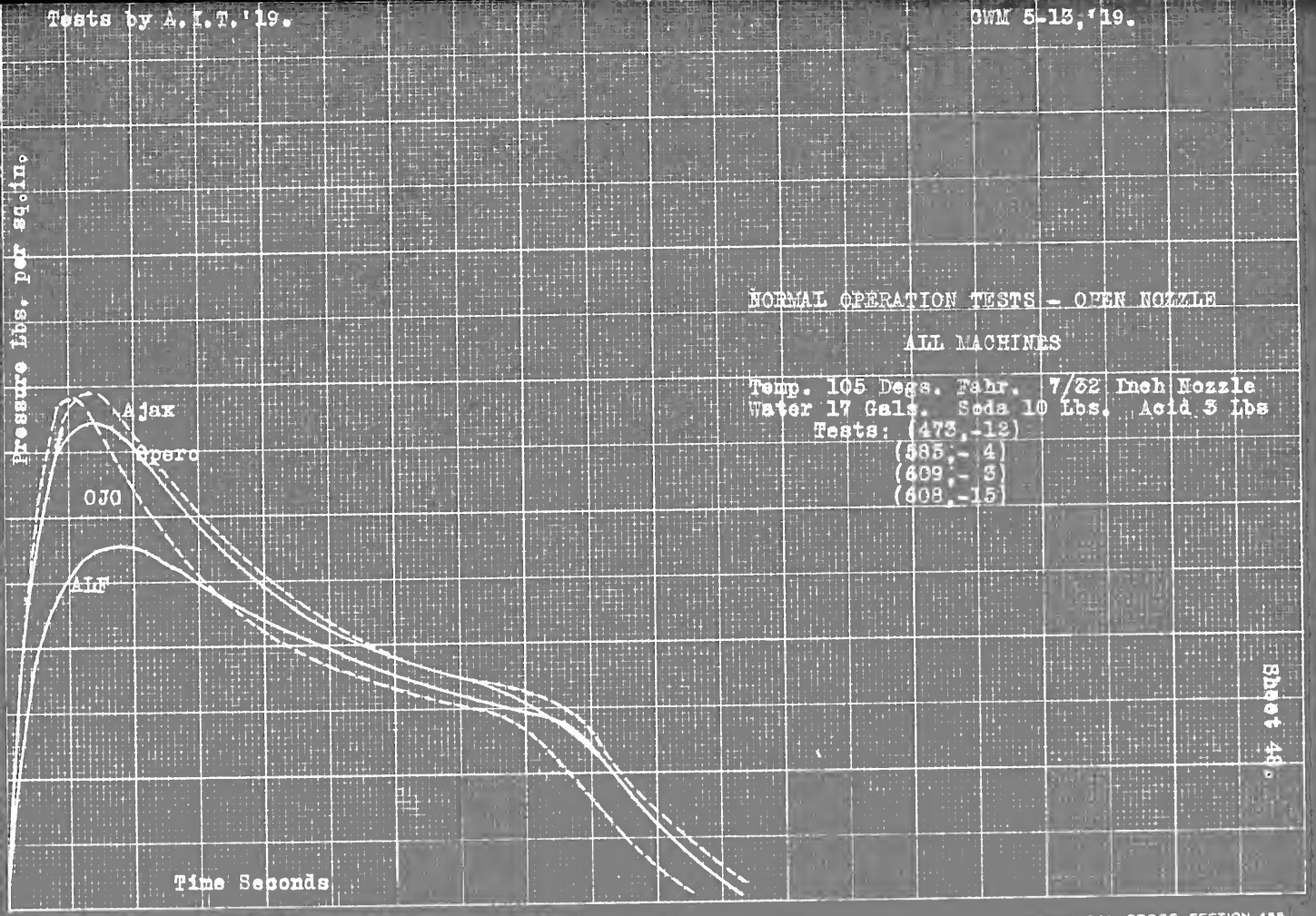
ALL MACHINES

Temp. 90 Degs. Fahr. 7/32 Inch Nozzle
Water 17 Gals. Soda 10 Lbs. Acid 3 Lbs.
Tests . (473,- 11.) L.L.F.
(586,- 3.) O.J.C.
(609,- 2.) Ajax
(608,- 5.) Spero

Sheet No. 47

Tests by A.I.T.'19.

CWM 5-13,'19.



NORMAL OPERATION TESTS - OPEN NOZZLE

ALL MACHINES

Temp. 105 Degs. Fahr. 7/32 Inch Nozzle
Water 17 Gals. Soda 10 Lbs. Acid 3 Lbs
Tests: (473,-12)
(585,- 4)
(609,- 3)
(608,-15)

Sheet 48.

UNIVERSAL CROSS SECTION 455

Tests by A.I.T. '19.

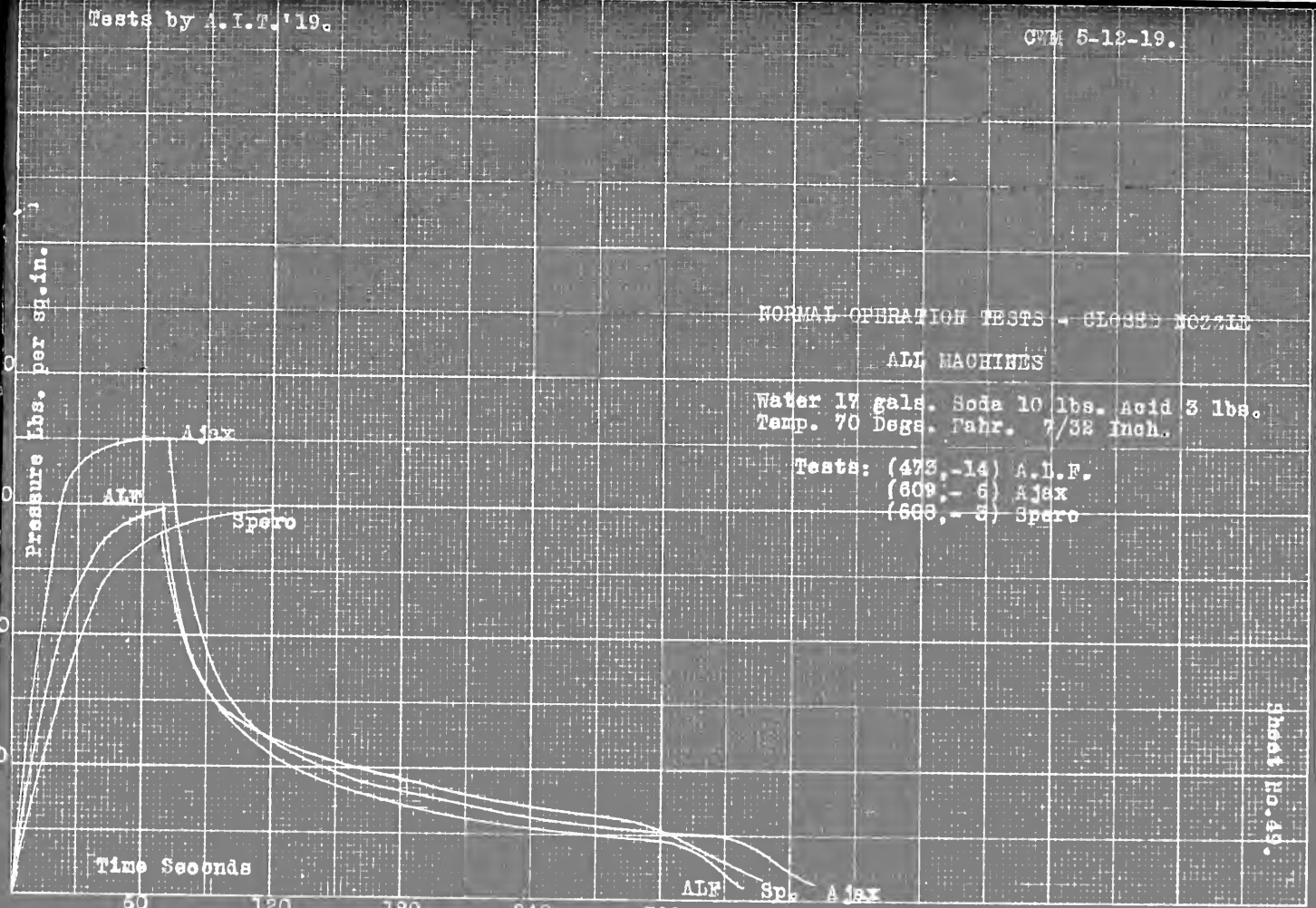
CWM 5-12-19.

NORMAL OPERATION TESTS - CLOSED NOZZLE

ALL MACHINES

Water 17 gals. Soda 10 lbs. Acid 3 lbs.
Temp. 70 Degs. Fahr. 7/32 Inch.

Tests: (473,-14) A.L.F.
(609,- 6) Ajax
(608,- 8) Spero

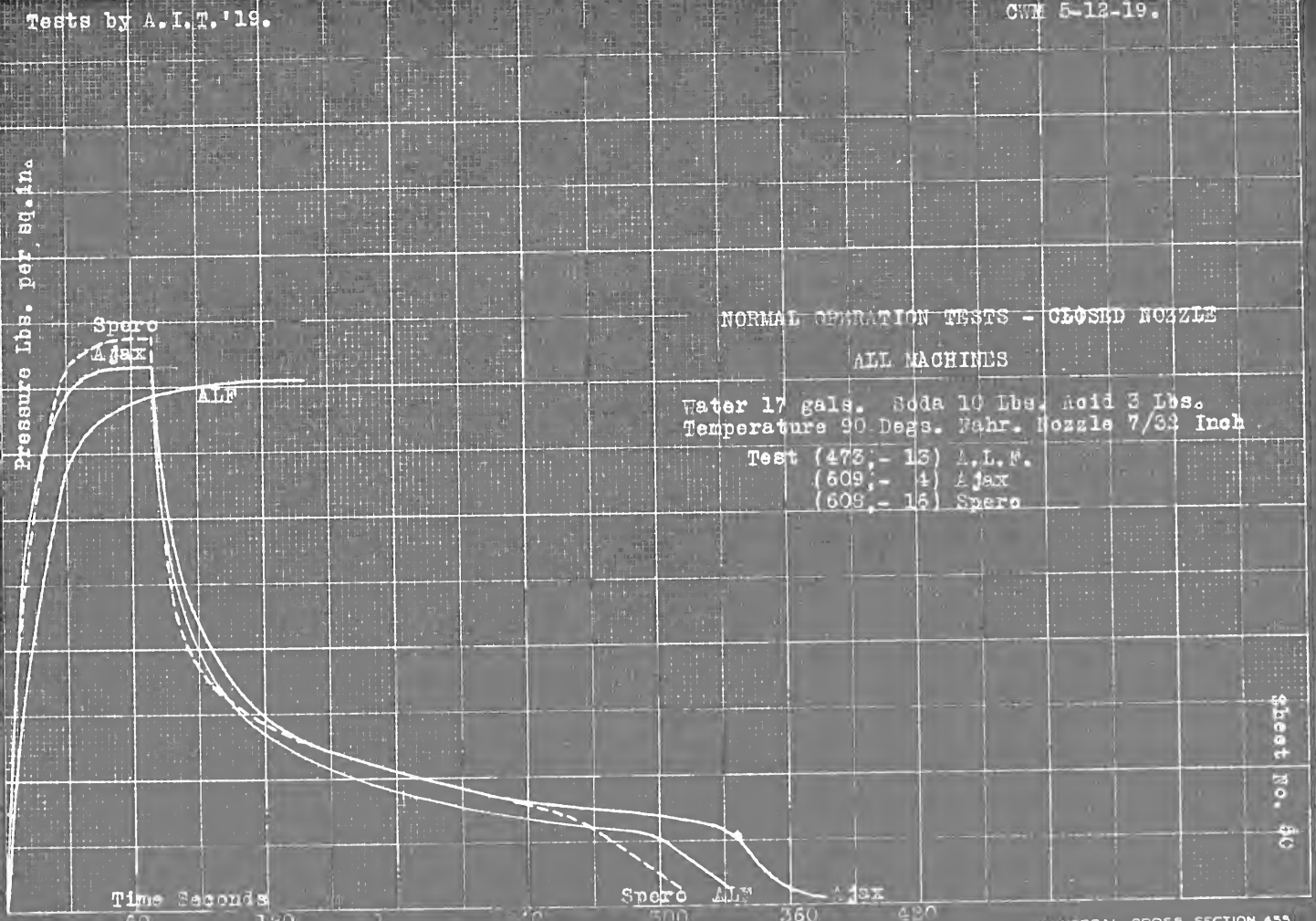


Sheet No. 49.

UNIVERSAL CROSS SECTION 455

Tests by A.I.T.'19.

CWH 5-12-19.



NORMAL OPERATION TESTS - CLOSED NOZZLE

ALL MACHINES

Water 17 gals. Soda 10 Lbs. Acid 3 Lbs.
Temperature 90 Degs. Fahr. Nozzle 7/32 Inch

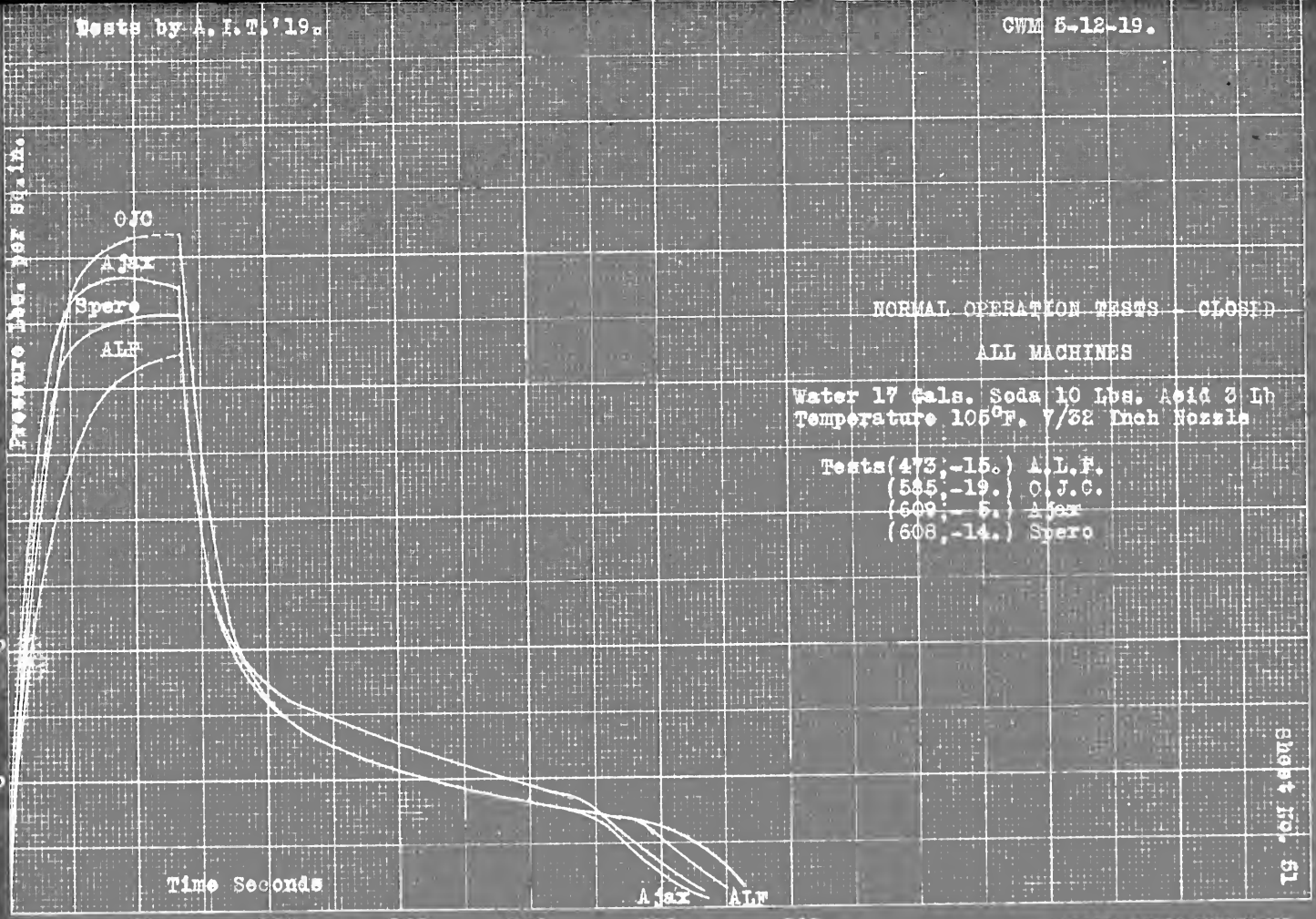
Test (473 - 13) A.L.F.
(609 - 4) Ajax
(609 - 16) Spero

Sheet No. 4C

UNIVERSAL CROSS SECTION 455

Tests by A.I.T.'19.

CWM 5-12-19.



NORMAL OPERATION TESTS - CLOSED

ALL MACHINES

Water 17 Gals. Soda 10 Lbs. Acid 3 Lb
Temperature 105°F. 7/32 Inch Nozzle

Tests (473,-15.) A.L.F.
(585,-19.) O.J.C.
(609,- 5.) Ajax
(608,-14.) Spero

Sheet No. 51

UNIVERSAL CROSS SECTION 455

PART V

DISCUSSION.

CHAPTER I. TEST VARIABLES.

CHAPTER II. THEORY OF OPERATION.

CHAPTER III. DESIGN.

PART V.

CHAPTER I.

TEST VARIABLES.

TEST VARIABLES.

There are three important classes of test variables, namely:

First,- Conditions that vary in the field, which are temperature, and whether nozzle is open or closed.

Second,- Charges of acid, soda and water.

Third,- Features of design of machine and parts.

In the emergency of fire there is an even chance that the machine will have its nozzle either open or closed at the start of operation. Consequently both open and closed nozzle tests should give satisfactory operation. As between open and closed nozzle tests, the latter seems to give more definite data with regard to the limits of operation. As may be seen on data sheet E, and as typically illustrated on curve sheet No. 45, the highest maximum pressures, lowest effective pressure (gas pressure) shortest final range and longest duration of stream are obtained in closed nozzle tests. However, the open nozzle tests have

the greater tendency to give acid stream samples and acid tank residue.

The effect of varying initial temperature is that the higher temperature gives higher maximum pressure, higher final pressure, longer final range, and shorter stream duration. There is also a greater tendency to give acid stream samples and acid tank residue. Curve sheets Nos. 5, 7, 8, 9, 10, 12, 18, 19, 20, 23, 24, 29, 30, 31 and 32.

The effect of decreasing the acid charge was to decrease the maximum pressure, decrease final pressure, decrease range and increase duration of stream. Curve sheets Nos. 6, 11, 21, 22, 33, 34, 35, 36, 37 and 38.

The effect of increasing the soda charge was to give high maximum pressures, high final pressures, longer final range and shorter duration. Curve sheet No. 43.

The effect of varying solution quantity within the range of tests run with constant chemical charges was that increasing or decreasing quantity from 17.3 gallons solution gave a higher maximum pressure. This irregular pro-

cedure is attributed to the fact that decreasing solution quantities, increases not only the gas space, but also the concentration of salts in solution. If no CO_2 was absorbed by the solution the maximum pressure would be inversely proportional to the gas space. However, some CO_2 does go into solution, the concentration of CO_2 in the solution being a certain ratio of the concentration of CO_2 in the gas space. This ratio is the absorption coefficient and depends upon the temperature pressure and degree of concentrations of salts. This is discussed in Part V, Chapter II.

Results of increasing size of nozzle orifice in open nozzle tests, were to give lower maximum pressure, higher pressure at gas, longer range, and shorter stream duration. This is shown on Curve sheets (3 and 14). With larger nozzle, there was a greater tendency to obtain acid tank residue and acid stream samples.

Effect of changing nozzle design with a given size of orifice is that with large waterways, the friction loss to the tip is

less, hence, effective pressure at orifice is greater, discharge is more rapid, and duration is shorter. Curve sheet 15; tests Nos. (585-2, and 9)

The principal effect of changing the design of strainer is to vary the quantity of tank residue. It is important that the tank residue be sufficient to neutralize any excess acid left in the tank because of the corrosive effect of the acid upon the tank galvanizing.

In tests (585-4,8) strainer No. 3 was used which gave three fluid ounzes residue, acid in character, while with identical conditions, tests (585-18, 14), strainer No. 4 was used which gave one pint residue, alkaline in character. Diminishing the total area of the holes in the strainer is apt to cause excessive friction loss at this point, especially if strainer becomes partly clogged with any foreign material.

In this investigation no such condition was approached, as effective strainer area was at least fifteen times area of nozzle orifice.

The main differences between different devices in operation characteristics, as shown on Curve sheet Nos. 46,47,48,49,50, and 51, are due to total tank capacity, rate of acid feed, and quantity of unused acid remaining in bottle.

Total tank capacities of the American La France and Spero extinguishers were ample, while capacities of the Childs and Ajax extinguishers were small. Rate of acid feed in American La France machine was slow, while in the three other devices, it was comparatively fast, the most rapid feed occurring in the Spero extinguisher. The American La France and Childs devices retained appreciable quantities of acid in the acid bottle, but the Ajax and especially the Spero machines retained almost negligible quantities.

Large tank capacities tends to give low maximum pressures and high pressures at gas. Slow acid feed gives slow rate of pressure increase and in open nozzle tests gives low maximum pressures and high pressures at gas. Retention of unused acid in bottle gives low maximum pressures and low pressures at gas.

In open nozzle tests of machines with slow acid feed, the maximum pressure is reached when a considerable quantity of acid has not had time to escape from the acid bottle into the bicarbonate solution. Because of this, the quantity of carbon dioxide at this time, and hence the pressure, is less than in machines of more rapid acid feed.

PART V.

CHAPTER II.

THEORY OF OPERATION.

THEORY OF OPERATION.

In closed nozzle tests upon starting operation of the extinguisher, the stopple falls part of the way out from neck of bottle and acid begins to flow rapidly into the bicarbonate solution. As the acid reacts with the bicarbonate carbon dioxide gas is formed. The bicarbonate is in excess, so that all the sulphuric acid which flows from the bottle is neutrallized by the bicarbonate, hence the carbon dioxide formed is proportional to its effective acid charge (initial less the residue in bottle) The carbon dioxide upon being formed tends to escape from solution as a gas, but a portion of the gas remains in the solution. The ratio of the concentration of gas in solution to concentration of free gas is a constant for a given pressure, temperature, and concentration of salts in the solution; and is called the absorption coefficient. According to "Henry's Law", the volume of a gas in solution is a constant proportion of the volume of the solution, regardless of the pressure, if the temperature is constant. This

is not strictly true in the case of carbon dioxide, as in water solution the absorption coefficient instead of remaining constant, decreases slightly as pressure increases.

In salt solutions the absorption coefficient may be expressed as

$y = ae^{-\frac{k}{x}}$ (Setchenow, Journal Chemical Society 1889)

y = absorption coefficient of solution

a = absorption coefficient of water at same temperature.

x = solution concentration (given as volume of solution)

k = constant. $e = 2.718$

Hence for salts which have no chemical reaction with CO_2, the absorption coeffieient decreases with the concentration of the salts.

According to Setchenow the absorption coefficient of CO_2 in water decreases with increase of temperature.

From this it follows that the pressure in the extinguisher is not strictly proportional to the carbon dioxide formed by reaction, but increases even more rapidly than the carbon dioxide constant increases.

Thus as the carbon dioxide is formed by action of the acid on the soda solution, the pressure rises until a maximum pressure is reached, at which time all the acid which flowed from the bottle has been neutrallized. There is at this time a large proportion of the total carbon dioxide in solution.

Upon opening the nozzle solution begins to discharge immediately, carrying large quantities of carbon dioxide in solution. As the solution discharges, the pressure drops, and part of the carbon dioxide in solution returns to the condition of a free gas.

The part remaining in the solution is due to supersaturation of the solution by CO_2. According to L. Pratesi, Journal of London Chemical Society, 1892, water saturated with CO_2 at a higher pressure will contain, upon released to a given pressure, 40 percent more CO_2 than a solution saturated at the given pressure.

In open nozzle tests the solution begins to discharge immediately, a lower maximum pressure is reached and less carbon dioxide is carried out with the solution.

PART V.

CHAPTER III.

DESIGN.

DESIGN.

(American La France - 473)

The stopple guide soldered on cap limited the travel of the stopple, thus restricting the acid feed and giving an acid residue in test (473-7). As this guide served no purpose in this machine and gave the undesirable result noted above, it is thought advisable to discontinue the use of the guide.

In every test, there remained 2 fluid ounces of acid in the acid bottle, and even after removal of stopple guide, an acid tank residue was obtained in test (473-12).

The bottle design is incorrect in that the shoulder of the bottle provides a recess in which acid is retained, and prolongs the discharge of acid.

The bottle should be designed to completely drain when the machine is in operating position. This may be accomplished by having the upper part of the bottle funnel-shaped to the mouth and having the angle that the neck makes with the axis of the bottle not greater than the tipping angle of the device.

The holes in the cage are insufficient in number and so located that some acid solution may be trapped in cage at cap and upon erecting after operation, acid solution acidifies tank residue.

The cage should have additional holes closer to the cap.

Type of nozzle submitted was satisfactory, but size of orifice of detachable tip was unsatisfactory and was discussed in Part V, Chapter I.

Connection of fittings to hose was unsatisfactory as the nozzle blew off hose at 280 lbs. test (608-17)

O. J. CHILDS (585)

Strainer No. 3, which was made for device out of 1 inch pipe with 40 5/32 inch holes, only retained 3 fluid ounces residue in tank which in test (585-4,8) was acid. Strainer No. 4, furnished by manufacturer retained one pint of residue in tank which in no cases was acid.

The bottle retained 3 fluid ounces of acid, consequently bottle should be revised to drain completely when machine is in operating

position.

The total tank capacity was 19-3/4 gallons, which should be increased to at least 20 gallons as the rated size.

AJAX (609)

Although no acid tank residues were obtained in any of the tests, the strainer should be so designed that the tank residue will be at least 1/2 pint.

With the present design of cage, ordinary tipping of the device will cause acid bottle to bend cage bars due to impact when handles strike floor. If this type of cage is used, four cage bars of heavier stock should be used, reinforced inches from top with ring which will retain bottle and also act as tank filling indicator. The distance between the prongs on the cap should be increased to eliminate possibility of striking neck of bottle when tightening or removing cap. These prongs are designed to come in contact with shoulder of bottle to prevent bottle from sliding toward cap.

The total tank capacity was 19.4 gallons, which should be increased to at least 20 gallons.

SPERO (608)

The cage and bottle furnished were practically the same as those furnished with the Ajax extinguisher, and the same suggestions apply. It was noted in test (608-1) that bottle cage was broken and bottle fell through cage. In test (608-13) cage rods were bent upon tipping machine.

Original strainer No. 1 had 1/4 inch holes which were larger than the nozzle orifice used, thus making strainer ineffective. Strainer No. 1 retained three pints of residue in tank and outlet fitting projected 3/4 inch into tank. As this residue is more than necessary to neutralize any remaining acid, outlet fitting was sawed to 3/8 inch projection, thereby reducing tank residue to one and one-half pints.

P A R T V I

C O N C L U S I O N S .

CONCLUSIONS.

Total capacity of the tank should not be less than twenty, nor more than twenty and one half gallons. Filling indicator should be so located that when tank is filled to the indicator, the capacity of the unfilled portion should not be less than two gallons and seven pints nor more than three gallons and one pint. This gives a fair allowance for variation in the manufacture of tank and location of filling indicator without appreciably affecting operation characteristics.

When an extinguisher as specified above, is filled with water to the indicator and a 10 lb. charge of sodium bicarbonate is used, 3 lbs. of 66° Baume commercial sulphuric acid gives the most satisfactory characteristics of operation. The maximum pressure with closed nozzle at 105 degrees Fahrenheit does not exceed 280 pounds per sq. in. At 70 degrees Fahrenheit, the pressure at gas is about 45 pounds in the open nozzle test and about 35 pounds in closed nozzle test. The minimum range of stream is about 40 feet. At

45 degrees, the pressure at gas is about 35 pounds in open nozzle test, and about 25 pounds in closed nozzle test. A somewhat smaller soda charge with a slightly larger acid charge would probably give at least as satisfactory operation unless acid residue or stream samples are obtained.

The bottle, stopple, and cage should be of such design that the rate of acid flow is neither too rapid nor unduly prolonged. The bottle should drain completely when the machine is in operating position in less than the time of operation obtained in high temperature open nozzle tests to eliminate all possibility of an acid tank residue.

The strainer should have holes 1/16 inch smaller in diameter than the nozzle orifice, the number of holes to be sufficient to give a total area equal to atleast fifteen times the area of nozzle orifice. The strainer should retain no less than one-half pint nor more than one and a half pint of residue in tank at the end of operation.

With 25 feet of ½ inch hose for the American La France type of nozzle, the 7/32 inch size of nozzle orifice should be used. This gives a stream duration of 3 1/3 minutes for a 70 degree open nozzle test and 4 minutes for a closed nozzle test. The minimum range is about 40 feet. For the Childs nozzle a smaller orifice than 7/32 inch should be used to give approximately the same stream duration and as long a range as the 7/32 inch diameter American La France nozzle.